No: Date:

Unit # 1

Measurement

(2-MCQS)

By:-

Saeeda Maryam

No: Date:

(Measurement)

Physics:-

The study of properties of matter, energy and their mutual relation.

→ The scope of physics is very wide.

→ Its scope range from the study of the tiniest sub-atomic particle such as electron → huge galaxies

minutest time (nano second) → age of universe.

→ Most basic braches:-

i) Mechanics

ii) Field Theory.

→ The conventional main branches:-

i) Mechanics

ii) Heat and Thermodynamics

iii) Acoustics

iv) Optics

v) Electricity

vi) Magnetism

vii) Atomic & Nuclear Physics

viii) Geophysics

(ix) Astrophysics

(x) Biophysics.

There are two main branches of sciences:-

i) Biological Sciences

ii) Physical Sciences

No: Date:

Science

Physical Sciences — concerned with non-living sciences

Biological Sciences. — concerned with living sciences.

Areas of Physics

Disciplinary Areas

• Pure branches of Physics

Mechanics
Heat and Thermodynamics
Electromagnetism
Optics
Sound
Hydrodynamics
Special Relativity
General Relativity
Quantum Mechanics
Atomic Physics
Molecular Physics
Nuclear Physics
Solid-state Physics
Particle Physics
Super conductivity
Super Fluidity
Plasma Physics
Magneto hydrodynamics
Space Physics.

Interdesciplinary Areas.
(Science + Physics)

Astrophysics
BioPhysics
Chemical Physics
Engineering Physics
Geophysics
Medical Physics
Physical oceanography
physics of music.

→ Physics is an experimental science and the scientific method emphasizes the need of accurate measurements of various measurable features of different phenomena ... of ...

No: Date:

Frontiers

- the world of extremely large
  - the universe itself.
- The world of extremely small
  - electron, proton, nuetron
- world of complex matter. World of middle-sized things.
  - molecules → world.

Branches:-

Nuclear Physics:-
deal with atomic nuclei

Particle Physics:-
concerned with ultimate particles of which matter is composed.

Relativistic mechanics:-
deals with velocities approaching that of light (3×10^8)

Solid State Physics:-
concerned with structure & properties of solids.

✯ Silicon Chips:-

The computer networks are products of chips developed from basic idea of Physics. The chips are made of silicon. Silicon is obtained from sand.

→ The silicon chips are utilized in the development of computers and electronic devices use to control various systems.

No: Date:

Measurement:-

Measuring of anything is to compare it with standard to see how big it is.

→ The standard with which things are compared is called a unit.

→ Magnitude of physical Quantity means a number and a proper unit.

Measurement of base quantity involved two steps:-

1) → choice of standard

2) → establishment of procedure to compare quantity to be measured with standard

Ideal Standard:-

An ideal standard has two characteristics:-

→ it is accessible.
→ it is invariable.
These are often incompatible.

a) Define Physical Quantities and understand that all physical Quantities consist of numerical magnitude and a unit.

Physical Quantities:-

Physics deals with numerous physical quantities in terms of which laws of physical laws are expressed.

e.g Volume, speed, force, time. etc.

No: Date:

→ These Quantities have to be measured accurately.

→ magnitude + unit → physical Quantity
e.g 4m.

Physical Quantities

Base Quantity
→ The minimum number of those physical quantities in terms of which other physical quantities can be defined.
e.g length, mass, time.

Derived Quantity
→ whose definitions are based on other physical Quantities. that is, the base quantity
e.g Velocity, Acceleration & Force etc.

(b) Define International System of units and understand SI base unit of physical Quantities and their base units.

<u>International system of units:-</u>
A complete set of units, both ~~physical~~, base & derived for all kind of physical quantities is called a system of units.

→ In 1960, international committee agreed on a set of definitions and standards to describe physical Quantities.

→ There are three kinds of units.

No: Date:

Kinds of units

- Base units
- Supplementary units
- Derived units

Base Units:-

These are seven base units for various physical quantities namely length, mass, time, temperature, electric current, intensity of light and amount of substance.

Physical Quantity	SI unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric Current	ampere	A
Thermodynamic Temperature	kelvin	K
Intensity of light	candela	cd
Amount of substance	mole	mol

Derived Units:-

Units used to express the derived quantities are called derived units.

Physical Quantity	Unit	Symbol	In term of B.U
Force	newton	N	$kgms^{-2}$
Work	joule	J	kgm^2s^{-2}
Power	watt	W	kgm^2s^{-3}
Pressure	pascal	Pa	$kgm^{-1}s^{-2}$
Electric Charge	coulumb	C	As
Magnetic Flux	weber	Wb	$kgm^2s^{-2}A^{-1}$

No: Date:

Supplementry Units:-

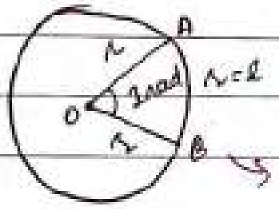
This class contain two units:-

(i) SI unit of plane angle (radian)

(ii) SI unit of solid angle (steradian)

Radian:- (rad)

The radian is the plane angle b/w two radii of a circle which cut off on circumference an arc, equal in length to radius.



1 rad = 57.3°

If $l = R$ then $\theta = 1$ rad.

→ two dimentional angle.

→ 1 rev = 2π radian
= 180°

→ expressed as ratio b/w two lengths.

$m \cdot m^{-1} = 1$

Steradian:- (sr)

The solid angle subtended at the centre of sphere by an area of its surface equal to square of radius of sphere.

→ three-dimensional.

→ 1 rev = 4π radian.

→ ratio b/w area and square of length.

$m^2 \cdot m^{-2} = 1$

No: Date:

Important Information

Computer Chips are made from wafers of the metalloid silicon, a semiconductor.

- Diameter of a nucleus → 10^{-5} m
- Diameter of an atom → 10^{-10} m
- Height of person → 10^{0} m.
- Diameter of Earth → 10^{5} m.
- Distance to sun → 10^{10} m.
- Distance to nearest star → 10^{15} m.
- Diameter of Milky Way Galaxy → 10^{20} m.
- Distance to nearest Galaxy → 10^{30} m

Other unit Systems

- CGS: cm, gm, sec.
- MKS: m, kg, sec
- FPS: foot, pound, second.
  - ↳ British system of units

Units of Some Quantities in CGS system:-

- 1 J → 10^{7} erg
- 1 T → 10^{4} Guass
- 1 Wb → 10^{8} Maxwell
- 1 N → 10^{5} dynes

SI = 10^{+ve} CGS

- erg → $g\,cm^2 s^{-2}$
- Guass → $g\,abA\,s^{-2}$
- Maxwell → $g\,abA\,cm^2 s^{-2}$
- Dyne → $g\,cm\,s^{-2}$.

(C) Use prefixes and symbols to indicate decimals submultiple, multiple or multiple of both base and derived units

multiples → +ve

submultiples → -ve

Factor	Prefix	Symbol
10^{-18}	atto	a
10^{-15}	famto	f
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	M
10^{-3}	milli	m
10^{-2}	centi	c
10^{-1}	deci	d
10^{1}	deca	da
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T
10^{15}	peta	P
10^{18}.	exa	E

No: Date:

d) Understand Errors and uncertenties including
- Systematic Error and Random Error
- Fractional & Percentage uncertainty
- Assessment of total uncertainty in final result.

Error:-

Difference b/w standard and experimental value is error

Qualitative.

Assignable (systematic)

- systematic error refers to the effect that influences all measurement of particular quantity equally.
- → produces consistent difference in readings.
- → may occur due to
  - i) zero error
  - ii) poor calibration
  - iii) incorrect marking.
- → It can be reduced by comparing instrument with other accurate one.
- → a correction factor can be applied.

Unassignable. (Random)

when repeated measurements give different values under same condition.

- → we cannot assign a cause because they don't follow a trend.
- → Repeating the measurement several times and taking an average can reduce effect of random error.

No: Date:

Quantitative

Absolute uncertainty or least count → zero error.

Fractional uncertainty or Relative error → $\frac{L.C}{M.V}$

Percentage uncertainty → $\frac{L.C}{M.V} \times 100$.

Imp L.C of

Michelson Interferometer	-	10^{-4} mm
Meter rod	=	0.1cm
Vernier calliper	=	0.01 cm
Screw Guage	=	0.001cm.

if $x = (\underbrace{10.1}_{L} \pm \underbrace{0.1}_{\Delta L})$ cm

Fractional unc $= \frac{\Delta L}{L} = \frac{0.1}{10.1}$

Percentage unc. $= \frac{\Delta L}{L} \times 100 = \frac{0.1}{10.1} \times 100$

Absolute uncertainty $=$ 0.1

Rules for Absolute uncertainty:-

Absolute unc. should have one significant figure e.g 0.1cm, 0.01cm, 0.001cm.

The unit of actual value and Absolute unc. should be same.

No: Date:

Assessment of total uncertainty in the final result:-

a) **For addition and Subtraction:-** Absolute uncertainties are added.

e.g $x_1 = 10.5 \pm 0.1 cm$
$x_2 = 26.8 \pm 0.1 cm.$

$x = x_2 - x_1$
$= 16.3 \pm 0.2 cm$

b) **For multiplication and division:-** Percentage uncertainties are added.

$$R = \frac{V}{I}$$

% unc. in R = (% unc of V + % unc. of I)

c) **For Power Factor:-** Multiply percentage uncertainty with that power

$$V = \frac{4}{3}\pi r^3$$

% unc. in V = 3 x %age unc. in radius r.

d) **For Time measurements:-**

$$\left[\frac{t_n}{n} \pm \frac{L.C}{n}\right]$$

stopwatch
L.C = 0.1 s

↳ By counting more vibrations

No: Date:

c) In average value of many measurements

i) Find average of measured values.
ii) Find deviation of each from average value.
iii) Find mean deviation.
iv) Mean deviation is the total uncertainty

e.g 1.20, 1.22, 1.23, 1.19, 1.22, 1.21

① $\frac{1.20+1.22+1.23+1.19+1.22+1.21}{6} = 1.21\,mm.$

② 0.01, 0.01, 0.02, 0.02, 0.01, 0.

③ $\frac{0.01+0.01+0.02+0.02+0.01+0}{6} = 0.01\,mm$

④ 0.01 mm.

Extra Topic.

Precision And Accuracy:-

Precesion:- Precision is the limit to which a quantity is measured, we can never obtain a result more preside than a limit of measuring device

Accuracy:- Accuracy is significance of closeness b/w the measured value and actual value of a quantity

[Information :-]

one year = 3.2×10^7 sec
One day = 8.6×10^4.

* Mass can be thought of as a form of energy.
mass is highly concentrated form of energy.

$$E = mc^2$$

* 1kg mass $\longrightarrow$ 9×10^{16} J energy.

* Colour printing uses just four colours.
cyan
magneta
Yellow
Black.

* Travel time of light :-

Moon $\rightarrow$ Earth 1min 20sec
Sun $\rightarrow$ Earth 8 min 20sec.
pluto $\rightarrow$ Earth 5hr 20sec.

* Atomic Clock :-
The cesium atomic frequency standard at the National institute of Standards and Technology in Colarado. Primary standard for unit of time.

No: Date:

meters in one light year = 9.5×10^{15} m.
seconds in one year = 3.1×10^{7} s
nanoseconds in 1 year = 3.15×10^{16} ns.
years in 1 second = 3.1×10^{-8} years

SI units:-

⇒ Gas constt =

$$PV = nRT$$

$$R = \frac{PV}{nT}$$

$$= \frac{Nm^{-2} \cdot m^3}{mol \cdot K}$$

$$= Nm\,mol^{-1}K^{-1}$$

$$= JK^{-1}mol^{-1}$$

⇒ Permittivity of free space:- (ϵ_0)

Nm^2C^{-2}

⇒ Unit of thermal conductivity:-

$$\frac{Q}{t} = \frac{KA\Delta T}{L}$$

$$K = \frac{QL}{A\Delta T t}$$

$$= \frac{Jm}{m^2 K s}$$

$$= Jm^{-1}K^{-1}s^{-1}$$

$$= Jm^{-1}s^{-1}(^\circ C)^{-1}$$

⇒ Magnetic Flux:-

$$\phi_B = BA$$

$$= NmA^{-1}m^{-2} \neq Nm/A ✓$$

⇒ Stefan's constt = $Wm^{-2}K^{-4}$.

⇒ Spefic resistance = ohm meter.

⇒ Electric Field intensity = Vm^{-1}

⇒ Planck's constt = kgm^2s^{-1}

No: Date:

* Percentage error in time

$$\text{Period} = \frac{L.C}{\text{no. of vib}} \times 100.$$

* All factors in an equation which are being added must have same units.

e.g

$$\left[P + \frac{a}{V^2}\right]\left[V - b\right] = RT$$

$$P = \frac{a}{V^2}$$

$$a = PV^2$$

$$= \frac{N}{m^2} (m^3)^2$$

$$= \frac{N}{m^2} \times m^6$$

$$= Nm^4$$

No: Date:

Topic-2 (3 MCQ'S)

Motion And Force

By:-
Saeeda Maryam

Trignometric Ratio:-

$\sin 30 = 1/2$ $\sin 60 = \sqrt{3}/2$ $\tan 30^\circ = 1/\sqrt{3}$

$\cos 60 = 1/2$ $\cos 30 = \sqrt{3}/2$

$\tan 60^\circ = \sqrt{3}$

$\sin 0^\circ = 0$ $\cos 90^\circ = 0$

$\sin 90^\circ = 1$ $\cos 0^\circ = 1$ $\tan 0^\circ = 0$

$\sin 45 = 1/\sqrt{2}$ $\tan 90^\circ = \infty$

$\cos 45 = 1/\sqrt{2}$

$\tan 45 = 1$

$ab = c$

$a = b^{-1}c$

$30 = \sin^{-1}\frac{1}{2}.$

No: Date:

(a) Understand the concept of displacement, distance speed, velocity and acceleration:

"no body is at absolute rest / abs. motion"

Rest and Motion:-

The concept of state of rest and motion are described relative to observer.

- if a body doesn't change its state w.r.t surroundings, it is in state of rest.
- if a body changes its position w.r.t its surrounding, it is in state of motion.
- A moving body can posses both the states of rest and motion, depending upon observer.

Displacement:-

The shortest distance b/w two points is called displacement.

- $\vec{d} \leq S$
- $\vec{d} = S$ (only in straight line)

→ change in position of body

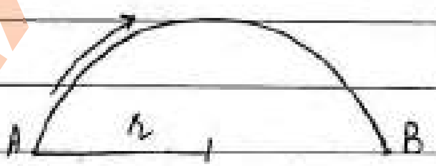
→ Vector Quantity

→ always straight line distance

$\left(\frac{dist}{disp} \geq 1\right)$ → cann't be less than 1

"For a moving object distance can never be zero but displacement can be zero."

↳ e.g for complete revolution in circle.



Displacement = 2r.

→ it may be positive, negative or zero.

→ unit → m

No: Date:

Distance:-

The total actual path traversed by a body between its initial and final position is called distance.

→ it is a scalar quantity
→ it is always positive
→ units → m.
→ it may be straight path or curved.

Distance = πr
↑ semicircle.

Speed:-

It is defined as rate of change of distance with respect to time.

→ scalar Quantity → units → ms^{-1} $d = \frac{s}{t}$
→ magnitude of velocity
• an object can have variable velocity but uniform speed e.g circular motion.

Velocity:-

Time rate of change of displacement of body is called velocity.

→ vector Quantity $\left(\frac{\text{speed}}{\text{velocity}} \geq 1\right)$
→ it may be +ve or −ve
→ units → ms^{-1}
→ Its direction is along the direction of disp.

$$\vec{v} = \frac{\text{Displacement}}{\text{Time}} = \frac{\Delta \vec{d}}{\Delta t}$$

$$\vec{v} = \frac{\vec{d_2} - \vec{d_1}}{t_2 - t_1}$$

Uniform Velocity:-

If body covers equal displacement in equal intervals of time

→ if instataneous velocity does not change, body is said to be moving with uniform velocity.

☆ Average Velocity:-

- If a body travels with uniform velocity v_1 for time t_1 and with uniform velocity v_2 for time t_2, then its average velocity will be.

$$\vec{v} = \frac{S_1 + S_2}{t_1 + t_2} \qquad v_{av} = \frac{v_1 + v_2}{2}$$

$$\vec{v} = \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2}$$

(Case 1) Time same, distance not same.

$$|v_{av}| = \frac{v_1 + v_2}{2}$$

(Case 2) Time change, distance same.

$$|v_{av}| = \frac{2 v_1 v_2}{v_1 + v_2}$$

Case of crossing bridge:-

S = length of train + length of bridge

(Case 3) Average velocity:-

$$|v_{av}| = \frac{\text{total distance travelled}}{\text{total time taken.}}$$

(Case 4) Instantaneous velocity = Average velocity

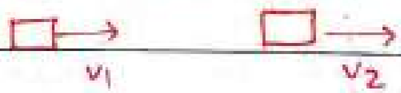
acceleration = 0

$S_1 = S_2$ (time same,

$t_1 = t_2$ distance same)

☆ Relative Velocity:-

(i) if object move in same direction



$$\boxed{v_{net} = v_1 - v_2}$$

(ii) if object move towards each other.

$$\boxed{v_{net} = v_1 + v_2}$$

No: Date:

Instataneous velocity:-

It is defined as limit of the ratio of change in position $\Delta\vec{r}$ (displacement) to the small time interval Δt as Δt following an instant 't' approaches to zero.

$$v_{inst} = \lim_{\Delta t \to 0} \frac{\Delta \vec{d}}{\Delta t}$$

Variable velocity:-

When body covers unequal displacement in equal intervals of time.

Acceleration:-

Rate of change of velocity is known as acceleration.

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} \qquad \vec{a} = \frac{v_f - v_i}{\Delta t}$$

→ vector Quantity

→ always in direction of force.

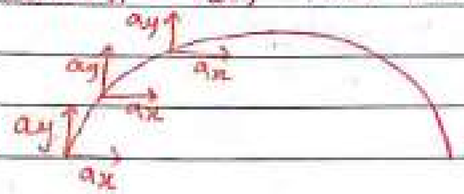
→ if only direction of velocity changes, $\vec{a}$ is $\perp$ to $\vec{v}$. It will be circular path and acceleration will be centripetal.

- disp and velocity are always in phase i-e parallel (linear, angular)
- velocity and acc are not parallel.

→ if only magnitude of velocity changes, acceleration is anti-parallel (180°) or parallel (0°) to $\vec{v}$

No: Date:

→ if both direction and magnitude changes, acceleration has two components.



→ if velocity inc → $a = +ve$
→ if velocity dec → $a = -ve$

Average Acceleration:-

if a body travels with uniform acceleration a_1 for time interval t_1 and with uniform acceleration a_2 for time interval t_2, then average acceleration

$$\vec{a} = \frac{a_1 t_1 + a_2 t_2}{t_1 + t_2}$$

Instataneous Acceleration:-

Acceleration of a body at a particular instant is called instataneous acceleration.

$$\vec{a}_{ins} = \lim_{\Delta t \to 0} \frac{\Delta \vec{v}}{\Delta t}$$

speed of moon around Earth $= 1000 ms^{-1}$
speed of sound (in air) $= 333$ m/s.
speed of earth around sun $= 29600 ms^{-1}$

Uniform Acceleration:-
→ If velocity of body changes by equal amount in equal intervals of time, the body is said to have uniform acc.

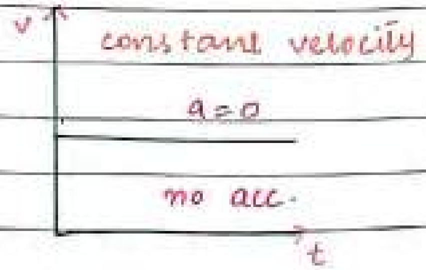
Avg acc = Inst acc.

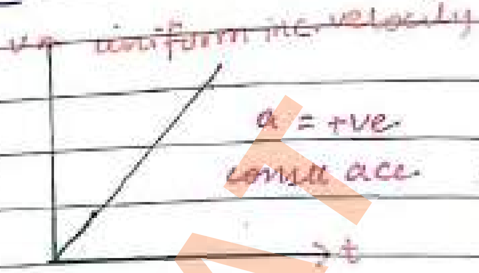
→ constt velocity
acc = 0
→ uniform velocity
acc → constt

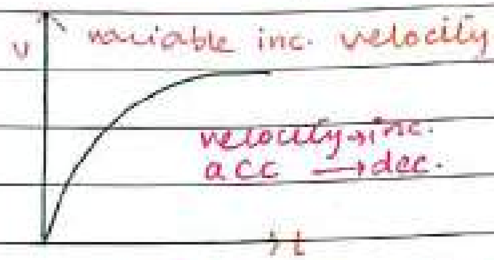
No: Date:

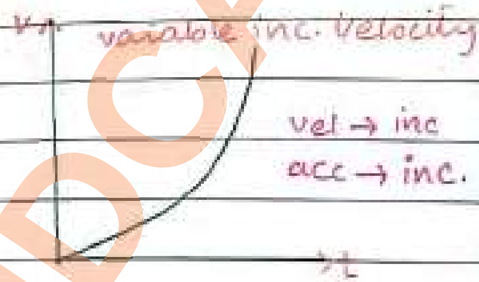
(b) Understand velocity time Graphs:-

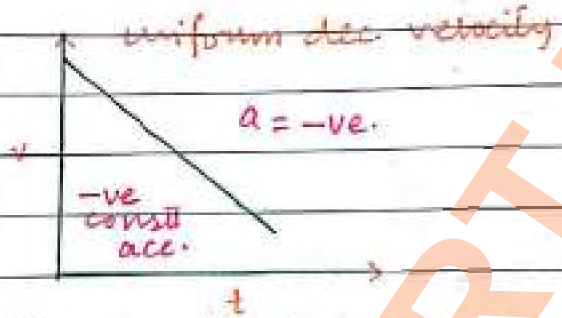
Velocity-Time Graph:-

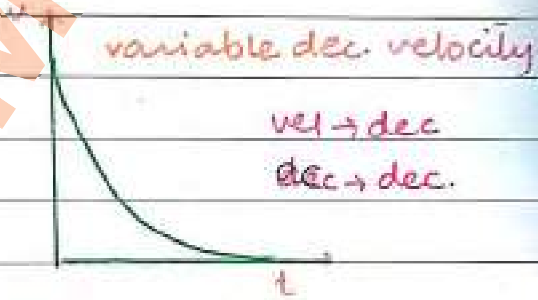


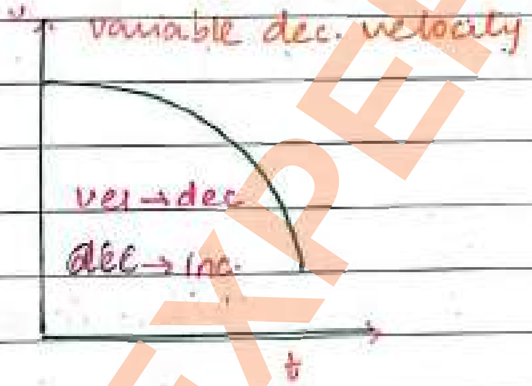


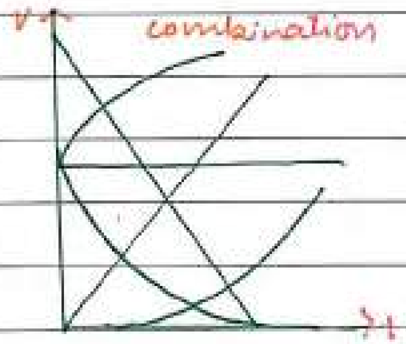












Slope of velocity time Graph:-
(gives acceleration)

$$\text{Slope} = \frac{\text{Perp}}{\text{Base}}$$

$$\vec{a} = \frac{\vec{v}}{t}$$

No: Date:

Area under velocity time Graph:-
(gives distance travelled by the object)

□ Area = length × width
= t × v

Slope = ratio
Area = Product.

△ Area = $\frac{1}{2} \times b \times h$
= $\frac{1}{2} \times v \times t$

(C) Review equations of motion.

Equations of Motion:-

Equations of Uniform Accelerated motion:-

① $v_f = v_i + at$
② $S = v_i t + \frac{1}{2} at^2$
③ $2aS = v_f^2 - v_i^2$

→ valid only for ~~straight line motion~~
→ const acc.

Distance travelled in n^{th} second:-

$S_n = v_i + \frac{1}{2} a(2n-1)$

For free fall:-
→ (if only gravitational force is acting)

(i) $t = \Delta v / g$
(ii) $S = \frac{1}{2} g t^2$ $t = \sqrt{2h/g}$
(iii) $2gh = \Delta v^2$ $v = \sqrt{2gh}$

Acceleration due to Gravity:-

→ a is replaced by g
if body is falling → (g → +ve)
if body is moving up → (g → -ve)

No: Date:

- When a body is dropped freely from the top of tower and another body is projected horizontally from same point, both will reach the ground at the same time at different points.

(d) Recall Newton's Laws of motion

Newton's Laws :- → empirical laws. → stated by Sir Issac Newton in famous book "Principia".

Newton's First Law of Motion :- → applicable to speeds less than c?.

→ Defines force.

→ also called law of inertia.

→ It states that everybody continue to be in state of rest or uniform motion along a straight line unless it is compelled to change that state by an applied force.

Inertia :-

→ The inability of body to change its state is called inertia.

↳ law of inertia of Galileo.

→ resist change in state of motion of body.

The frame in which Newton's first law is holds is called inertial frame of reference.

Newton's Second Law of Motion :-

→ measures force

→ The effect of an applied force on a body is to cause it to accelerate in direction of the force.

$$\checkmark F = ma \qquad \left(F = \frac{\Delta P}{t}\right)$$

Weight :-

equal to force with which body is attracted by earth toward its centre

No: Date:

→ it states that to every action there is equal and opposite reaction.

Inertia → physical property not Quantity

weight → Quantitative measure of inertia.

(e) Define momentum and describe law of conservation of momentum.

Momentum:-

The simple product of mass & velocity is called momentum.

$$\vec{P} = m\vec{v}$$

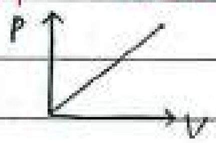
→ it is a vector Quantity → pointing along $\vec{v}$

→ unit → $kgms^{-1}$ / Ns

→ The idea of linear momentum was introduced by Newton.

→ Dimensions → $[MLT^{-1}]$

If m → constt



Law of conservation of momentum:-

For isolated system.

$$P_{i(t)} = P_{(f)\,t}$$

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

" The total linear momentum of an isolated system remain constt."

isolated system → no external force.

No: Date:

→ it states that to every action there is equal and opposite reaction.

Inertia → physical property not-Quantity

weight → Quantitative measure of inertia.

(e) Define momentum and describe law of conservation of momentum.

Momentum:-

The simple product of mass & velocity is called momentum.

$\vec{P} = m\vec{v}$

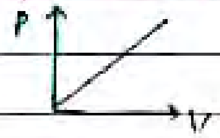
→ it is a vector Quantity → pointing along $\vec{v}$

→ unit → $kgms^{-1}$ / Ns

→ The idea of linear momentum was introduced by Newton.

→ Dimensions → $[MLT^{-1}]$

If m → constt



Law of conservation of momentum:-

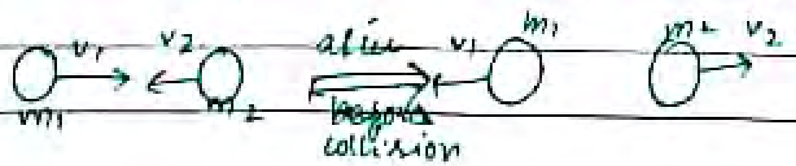
For isolated system.

$P_{i(t)} = P_{f(t)}$

$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

" The total linear momentum of an isolated system remain constt."

isolated system → no external force



No: Date:

(i) $m_1 = m_2$

→ perfect headon collision

→ velocities will interchange.

→ $v_1' = v_2$, $v_2' = v_1$.

(ii) $m_1 = m_2$ (m_2 at rest)

→ m_1 will stop

→ $m_2 = v_1$

→ For two objects if momentum is constt:-

$m_1 v_1 = m_2 v_2$

$\frac{m_1}{v_1} = \frac{v_2}{v_1}$

(iii) $m_1 >> m_2$

→ $v_2 = 0$

→ $v_1' = v_1'$

$v_2' = 2 v_1$

(iv) $m_1 << m_2$

→ $m_2 = 0$

→ $v_1' = -v_1$

→ $v_2 = 0$

(f) Define and explain the relation b/w force and rate of change of momentum.

Momentum & 2nd Law of Motion:-

$F = ma$

$F = m(\frac{vf - vi}{t})$

$F \times t = mvf - mvi$

$F \times t = \Delta P$

$F = \frac{\Delta P}{t}$ ⇒ Ratio of impulse to time gives force.

No: Date:

(g) Define impulse and understand the concept $I = F \times t = mv_f - mv_i$.

→ Product of force & time gives impulse.

→ units → $kgms^{-1}$

→ When large force acts on a body for a very short time.

$I = F \times t$

$\Delta P = I = F \times t$.

$F = \frac{\Delta P}{t}$

$\left(F = \frac{m_1v_1 - m_2v_2}{t}\right)$

→ Impulse is time effect of force on an object.

(h) Understand Projectile motion and its applications

Projectile Motion:-

→ two dimentional motion (x, y)

→ motion of particle is constrained in a plane

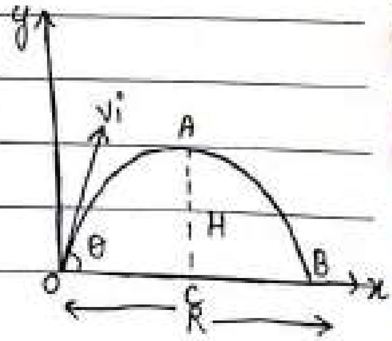
→ neglecting all external factors.

→ when the object is thrown obliquely near the earth's surface → it moves in a parabolic pathway, provided the particle remain close to earth surface.

→ Two types.

Terms used in Projectile motion:-

A particle projected from point 'O' with initial velocity 'v_i' at an angle 'θ' with horizontal.



No: Date:

- Point O → Point of projection
- Angle θ → Angle of projection
- Distance OB → horizontal range
- Height AC → Maximum Height / vertical Range
- Total time taken by particle in describing the path OAB → time of flight.
- Horizontal coordinate:–

  $x = v_i x \cos\theta\, t$
- Vertical coordinate:–

  $y = v_i y \sin\theta\, t - \frac{1}{2} g t^2$

Horizontal Projectile:–

★ v_x → constt (as $a_x = 0$ then no change in velocity)

★ at certain height → $v_y = 0$

★ When the object is moving downward the vertical component constantly increases.

Acceleration:–

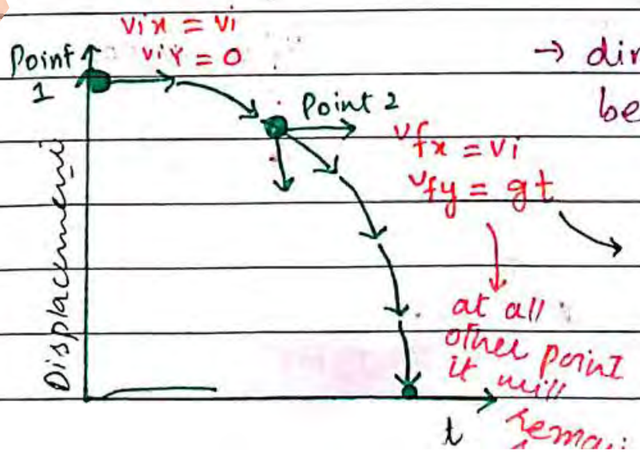
$a_x = 0$

$a_y = g$ (because object is moving under gravity)

→ In projectile motion trajectory is drawn under displacement – time graph

Acc → constt

Motion → Rectilinear



→ direction changes because of gravity

$v_{fy} = v_{iy} + gt$

$v_{fy} = 0 + gt$

$v_{fy} = gt$

No: Date:

Distance along horizontal:-

$$S = v_i t + \frac{1}{2} a t^2$$

$$x = v_{ix} t + \frac{1}{2} a_x t^2$$

$$x = v_{ix} t + \frac{1}{2}(0) t^2$$

$$x = v_{ix} t. \qquad \boxed{x = v\cos\theta\, t}$$

Distance along vertical:-

$$S = v_i t + \frac{1}{2} a t^2$$

$$Y = v_{iy} t + \frac{1}{2} g t^2$$

$$y = (0)t + \frac{1}{2} g t^2$$

$$(h)\ y = \frac{1}{2} g t^2$$

Also, when body is dropped from certain height

Time of flight:-

$$h = \frac{1}{2} g t^2$$

$$t^2 = \frac{2h}{g}$$

$$t = \sqrt{2h/g}$$

$$t = \sqrt{2h/10}$$

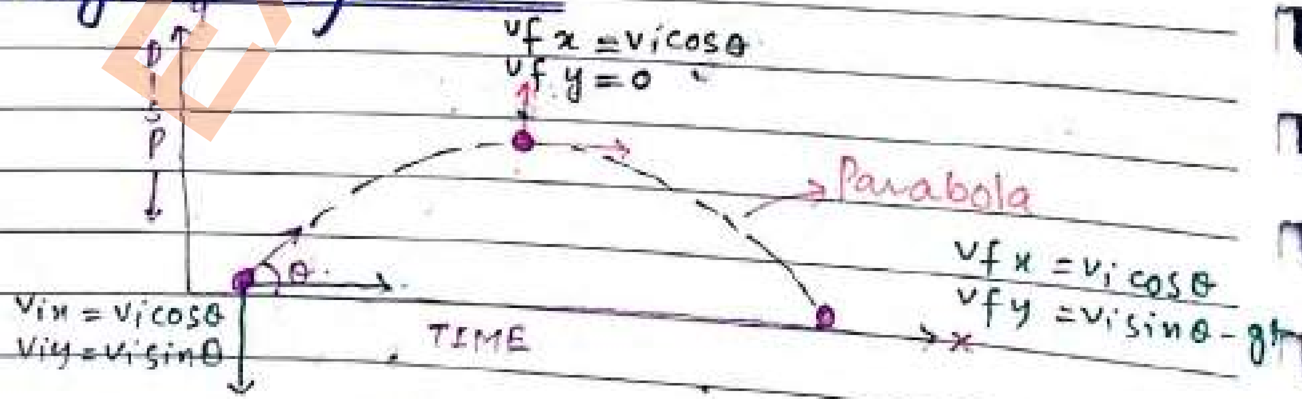
$$t = \sqrt{h/5}$$

Imp
The magnitude of velocity at any instant

$$v = \sqrt{v_{fx}^2 + v_{fy}^2}$$

$$\tan\phi = \frac{v_{fy}}{v_{fx}}$$

Oblique Projectile:-



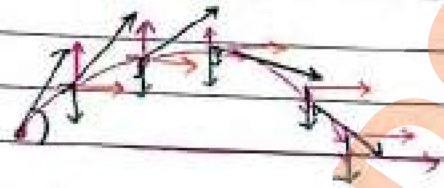
No: Date:

velocity maximum → at starting and ending point

Velocities at opposite points → same.

velocity at midpoint → only along x-axis.
along y-axis → 0

As body moves up → y-component decrease
x-component constt.



Angle b/w vx and gravity = 90°
Angle b/w vy and gravity = 180° (1st half)
Angle b/w vy and gravity = 0° (2nd half)
Angle b/w v and gravity = continuously decreases.

Height of the Projectile:-

$$H = \frac{v_i^2 \sin^2\theta}{2g}$$

max height → middle point.

$H \propto v_i^2$
$H \propto \frac{1}{g}$ → at moon it will be more as g → less.
$H \propto \sin^2\theta$

at $\theta = 90°$

$$H = \frac{v_i^2}{2g}$$

$$H = H_{max} \sin^2\theta$$

No: Date:

Time of Flights:-

$$T = \frac{2v_i \sin\theta}{g}$$

$T \propto v_i$

$T \propto 1/g$

$T \propto \sin\theta$

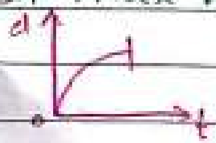
at $\theta = 90^\circ$

$$T = \frac{2v_i}{g}$$

$$T = T_{max} \sin\theta$$

- At $\theta = 76^\circ$ max height and range become equal.

Time to reach max height



$$T' = \frac{v_i \sin\theta}{g}$$

$$T' = T/2$$

Range of Projectile:-

$$R = \frac{v_i^2 \sin 2\theta}{g}$$

$R \propto v_i^2$

$R \propto 1/g$

$R \propto \sin 2\theta$

at $\theta = 45^\circ$

$$R = \frac{v_i^2 \sin 2(45)}{g}$$

$$R_{max} = \frac{v_i^2}{g}$$

$$R = R_{max} \sin 2\theta$$

Imp.

- Range will be max at 45°
- If θ is not 45° the it will be max at the θ nearest to 45°
- If $\theta_1 + \theta_2 = 90^\circ$ ranges will be equal on both these angles

No: Date:

Relation of Rmax & Height:-

$$\frac{v_i^2 \sin^2\theta}{2g} = \frac{v_i^2}{g}$$

$$H = \frac{R_{max}(\sin^2\theta)}{2}$$

$\theta = 45°$

$$H = \frac{R_{max}(\sin 45°)^2}{2}$$

$[\because \sin 2\theta = 2\sin\theta\cos\theta]$ $$H = \frac{R_{max}(1/\sqrt{2})^2}{2}$$

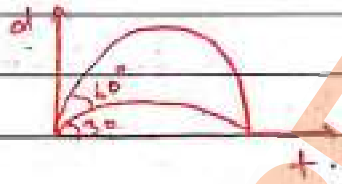
$$H = \frac{R_{max}}{4}$$

$$H = \frac{1}{4} R_{max}$$

$$\boxed{R_{max} = 4H}$$

$$\boxed{4H = R\tan\theta}$$

$$\boxed{8H = gt^2}$$



For supplementery angles range is same

Kinetic Energy at Maximum Height:-

$$K.E_{max} = \frac{1}{2} m v_x^2$$

$$= \frac{1}{2} m(v\cos\theta)^2$$

$$= \frac{1}{2} mv^2 \cos^2\theta$$

$$\boxed{K.E_{max} = K.E_i \cos^2\theta}$$

$$\boxed{P.E_{max} = P.E_i \sin^2\theta}$$

No: Date:

(i) Applications:-

→ an un-powered and un-guided missile is called ballistic missile.

→ Friction of air effects the horizontal and vertical motion of the missile

→ Ballistic missile are useful only for short ranges.

→ Powered and remote control guided missiles are used for long ranges and precision.

(2) Define moment of force or torque and use of torque due to force.

Torque:-

A physical Quantity which produces angular acceleration, is called Torque.

or

The turning effect of force is called torque.

→ dimentionally it resembles with work.

→ vector Quantity

→ also called moment of force.

$$\vec{\tau} = \vec{r} \times \vec{F}$$

$\vec{F}$ → Force

$\vec{r}$ → Position vector

$$\tau = rF\sin\theta$$

↳ moment arm.

No: Date:

Special Cases:-

Then $\tau = 0$ and rod will not rotate

Then $\tau = 0$ and rod will not rotate

Then $\tau = max$ and it will rotate.

Other Formulae:-

$$\tau = r F_{\perp} = r(F \sin\theta)$$

$$\tau = r_{\perp} F = (r \sin\theta)F$$

Moment arm:-

The perpendicular distance b/w line of action of force and axis of rotation is called moment arm.

$\vec{\tau}$ = Torque is axial vector

↳ having direction along axis of rotation.

Direction:-

→ Along axis of rotation

→ perpendicular to the plane containing r & F

→ Direction also found by right hand rule.

No: Date:

Positive and Negative Torque:-

Direction is Clockwise → −ve
Direction is anticlockwise → +ve

Maximum:-

if $\theta = 90°$

$\tau_{max} = rF\sin\theta$
$= rF(\sin 90°)$
$= rF(1)$
$= rF$

Unit:- Nm

Zero torque:-

of our earth

if (i) $r = 0$
(ii) $F = 0$
(iii) $rF\sin 0°$
(iv) $rF\sin 180°$

Imp: uniform angular velocity = torque = 0

→ if line of action of force passes through pivot point then magnitude of torque will be zero

→ if force is applied across the pivot point τ will be zero

Direction Alteration:-

→ if $\vec{F}$ is reversed, then direction of τ is reversed.

→ If $\vec{r}$ is reversed, then direction of τ is reversed.

→ if both $\vec{r}$ and $\vec{F}$ are reversed the direction remains unchanged.

"The analogous of force in rotation is torque"

→ If body is rotating with constant angular acceleration, the torque is uniform.

No: Date:

Couple:-

$\tau = l \times F$ (l → perpendicular distance b/w forces)

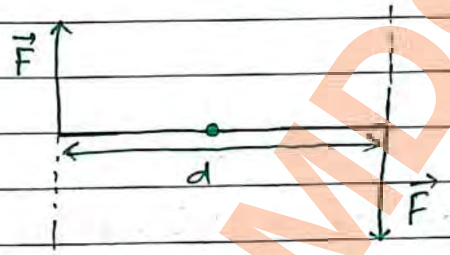
$\tau = lF\sin\theta$

$\tau = lF\sin 90^\circ$

$\tau = lF(1)$

$\tau = lF$

→ Two equal, opposite and non-collinear forces acting on a body constitute a couple.



→ Torque of couple is never zero and $\tau = Fd$ where d = momement arm of couple.

Condition:-

(i) There should be two forces equal in magnitude but opposite in direction

(ii) These are applied at different points of same body.

(iii) The ⊥ distance b/w line of action of two forces.

(j) Define the equilibrium, its conditions and use it to solve problems

Equilibrium:-

If a body keeps its state of rest or uniform motion invariant under many forces

No: Date:

it is said to be in perfect equilibrium.
Acceleration and Force will be zero

Conditions of Equilibrium:-

The conditions of equilibrium can be stated in term of coplanar forces as follows.

1st condition of Equilibrium:-

⇒ The sum of forces acting on body is equal to zero.

i-e $\Sigma F = 0$

For coplanar forces:

$$\Sigma \vec{F}_x = 0$$
$$\Sigma \vec{F}_y = 0$$

⇒ 1st condition of equilibrium controls the translational equilibrium of body.

2nd condition of equilibrium:-

⇒ The torques sum acting on body about same axis of rotation is equal to zero

$$\Sigma \vec{\tau} = 0$$

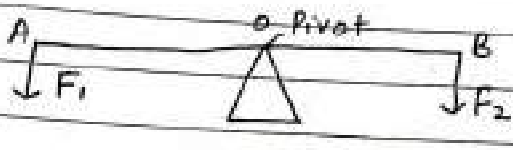
Sum of anticlockwise torque = Sum of clockwise torques

⇒ 2nd condition of equilibrium controls the rotational equilibrium of body.

Principle of moments:-

$$\tau_1 = \tau_2$$
$$OA \times F_1 = OB \times F_2$$

No:
Date:



Equilibrium

Static — $v=0, a=0, F=0$; $\omega=0, \alpha=0, \tau=0$

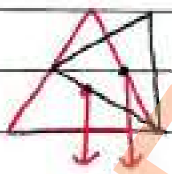
dynamic

Translatory — $v=$ uniform then $a=0$

Rotatory — $\omega=$ uniform $\alpha=0$ $F=0$

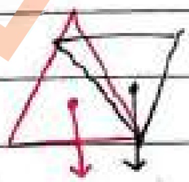
Stable Equilibrium:-

When object is disturbed, C.G rises, P.E increases but line of action of weight remains with base area.



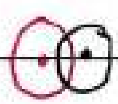
Unstable Equilibrium:-

C.G Falls, P.E decreases, line of action of weight doesn't remain in same area



Nuetral:-

C.G. remains at same height, P.E const



No: Date:

Multiple Choice Questions.

MCQ's A particle moving in a circle of radius r. After half revolution the displacement will be.

✓ a) $2r$
b) πr
c) r^2
d) d^2

MCQ After one fourth revolution the displacement and distance will be resp:-

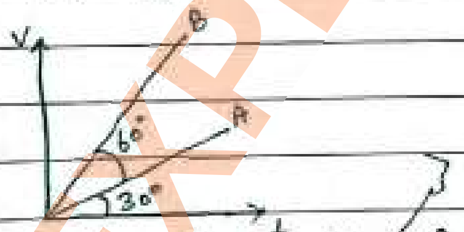
✓ a) $\sqrt{2}r$, $\pi r/2$
b) $2r$, $\pi r/2$
c) $5r$, $2\pi r$
d) $2\sqrt{2}r$, $r/4$

MCQ After half revolution the ratio of distance to displacement will be.

✓ a) $\pi/2$
b) $2\pi/2$
c) $4\pi/2$
d) None of these

$\frac{\pi r}{2r}$

MCQ



Find slopA : Slope B

$= \frac{\tan 30°}{\tan 60°} = \frac{1/\sqrt{3}}{\sqrt{3}}$

$= \frac{1}{\sqrt{3}\sqrt{3}} = \frac{1}{3}$

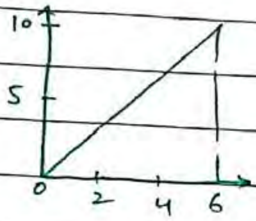
MCQ

Find Slope A : Slope B.

$= \frac{\tan 30°}{\tan 60°} = \frac{1}{3}$

No: Date:

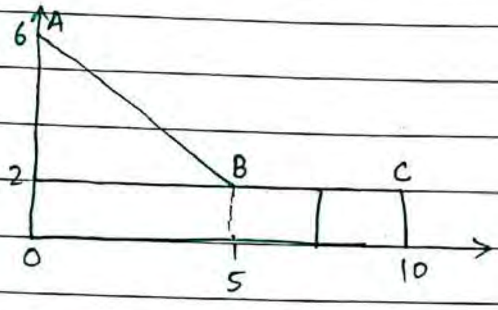
MCQ



Find Area

$= \frac{1}{2} \times 6 \times \cancel{10}^{5} = \underline{30}$

MCQ

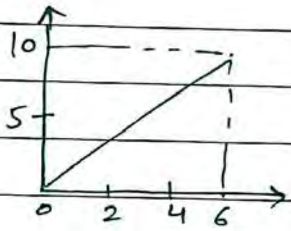


Find Area under slope $\underline{A \text{ \& } B.}$

$= 2\times 5 + \frac{1}{\cancel{2}} \times 5 \times \cancel{4}^{2}$

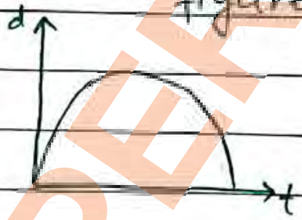
$= 10+10 = 20.$

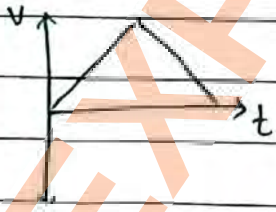
MCQ

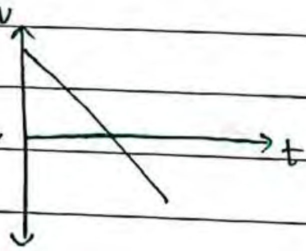


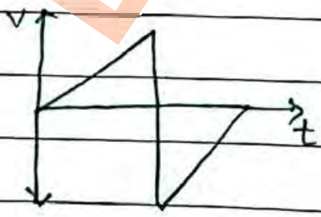
Find slope. $\frac{1}{\cancel{2}} \times \cancel{6}^{3} \times 10 = \underline{30}$

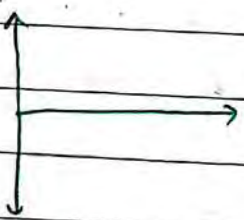
MCQ Which graph shows the condition shown in figure.



a) 

c) ✓ 

(b) 

d) 

No: Date:

MCQ Object is rotating A.C.W then direction of torque will be:

a) clockwise
b) anticlockwise
✓c) upward
d) downward

MCQ Object is rotating C.W then magnitude of τ will be:

a) +ve
✓b) −ve
c) downward
d) upward

Concept

$\sin(90 \pm \theta) = \cos\theta$

$\cos(90 \pm \theta) = \sin\theta$

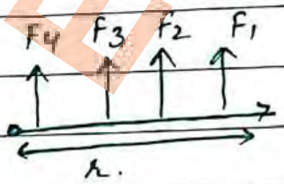
MCQ If θ b/w r and F is 0° then torque will be

✓a) null vector
b) 0

MCQ If θ b/w r and F is 0°, then magnitude of torque will be

✓a) zero
b) null vector.

MCQ



For which for (all having same magnitude) Force (τ) will be minimum

a) F_1 c) F_3
b) F_2 ✓d) F_4.

No: Date:

MCQ The angle b/w $\vec{r} \times \vec{F}$ and $-\vec{F} \times \vec{r}$ is

✓a) 0°

b) 180°

c) 90°

d) 98°

MCQ If r and F both reverse the torque will

a) reversed

✓b) remain same.

c) r change F don't change.

Imp concept
- v = constt/uniform
- $a = 0$
- $F = 0$
- ω = constt/ uniform
- $\alpha = 0$
- $\tau = 0$

MCQ If $I_1 : I_2 = 2:3$ and $\alpha_1 : \alpha_2 = 4:1$ then find $\tau_1 : \tau_2 = ?$

a) 3 : 8

b) 8 : 3

c) 4 : 3

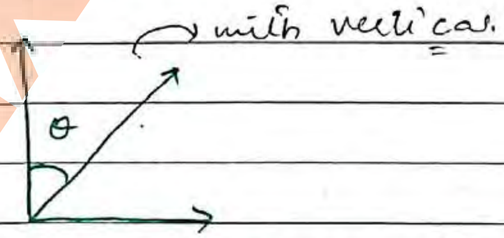
d) 5 : 3

$\tau_1 = I_1 \alpha_1$
$= 2 \times 4 = 8$

$\tau_2 = I_2 \alpha_2$
$= 3 \times 1 = 3$

8 : 3.

MCQ



In given diagram, the relation of torque is

a) $rF\sin\theta$

b) ✓ $rF\cos\theta$

c) rF

d) $rF\tan\theta$.

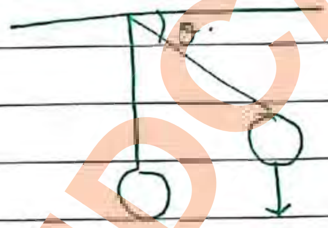
No: Date:

MCQ In the given diagram the magnitude of torque can be increased by:

✓a) decreasing θ
b) increasing θ
c) remaining same
d) None of these

MCQ The relation of torque for given pendulum is

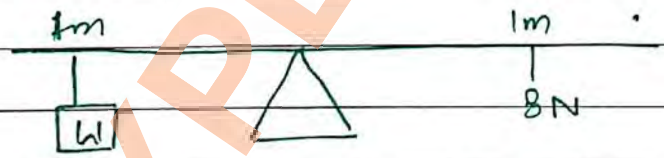
a) $l mg \sin\theta$
✓b) $l mg \cos\theta$
c) $l \, mg \tan\theta$
d) mg.



MCQ When Force is applied $\boxed{\text{to pivot}}$ point of object, its motion could be.

a) rotatory
✓b) translatory
c) not possible
d) both

MCQ

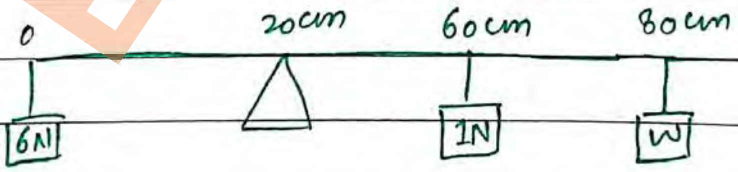


$2W = 8$

$W = 8/2 = 4N$

What will be w?

MCQ



What will be weight.

~~$20 \times 6 = 40 \times 1 + 60W$~~

$120 = 40 + 60W$

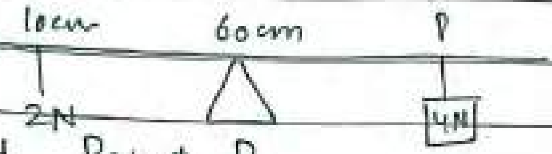
$120 - 40 = 60W$

$W = \frac{80}{60}$

$= 4/3.$

No: Date:

MCQ



Find Point P.

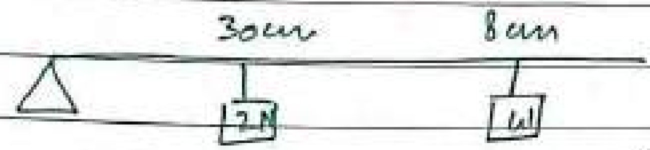
$50 \times 2 = x \times 4$

$x = 100/4 = 25cm.$

$P = 100 - 25$

$= 75cm.$

MCQ



Find weight?

$0 = 0.3 \times 2 + 0.8W.$

$0 = 0.6 + 0.8W$

$-0.6 = 0.8W$

$W = -0.6/0.8 = -6/8 = -3/4.$

MCQ

Find resultant torque.

$0.2 \times 2 = 4N \times 0.3.$

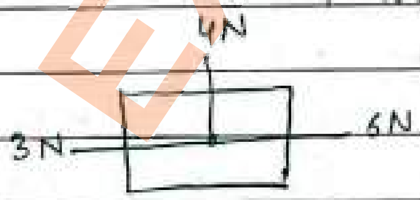
$0.4 = 1.2.$

$1.2 - 0.4 = \boxed{0.8 Nm}$

MCQ When Force is applied on an object, the quantity which is must produced?

a) momentum
b) velocity
c) acceleration ✓
d) All of These

MCQ



What will be resultant Force.

$= \sqrt{4^2 + 3^2}$

$= \sqrt{16+9} = \sqrt{25} = 5$

No: Date:

MCQ A person walks towards east, the direction of force b/w foot and the ground is towards.
- ✓a) east
- b) west
- c) north
- d) south

Frictional Force is opposite to applied.

MCQ An object starts moving from rest with a = 10ms-1, the distance covered in 3rd second is
- ✓a) 25m
- b) 800m
- c) 100m
- d) 35m.

$= \frac{a}{2}(2n-1)$

$= \frac{10}{2}(2(3)-1)$

$= 5(6-1)$

$= 25$.

MCQ A body is dropped from height of 19.6m. Time taken by it to reach the ground will be
- ✓a) 2sec
- b) 4 sec
- c) 1 sec
- d) 0 sec

$h = \frac{1}{2}gt^2$

$\frac{19.6 \times 2}{9.8} = t^2$

$4 = t^2$

$t^2 = 4$

$\sqrt{t^2} = \sqrt{4}$

$= 2$

MCQ A crickter catches a ball of mass 150g in 0.01 sec with speed 20ms-1 The Force experienced by crickter will be:.
- ✓a) 300N
- b) 0.3N
- c) 3N
- d) 30N

$m = 150g = 0.15kg$

$t = 0.01$

$v = 20m/s$

$F = \frac{mv}{t}$

$= \frac{0.15 \times 20}{0.01}$

$= 300$

No: Date:

MCQ A body of mass (2kg) collide with a speed of 100m/s on ground, then bounce back with same speed, find force if time of contact was 1/50 sec.

a) 2×10^{-4} N

✓ b) 2×10^{4} N

c) 0

d) None.

$= \frac{2mv}{t}$

$= \frac{2(2)(100)}{1/50}$

$= 2\times10^{4}$

MCQ A body drawn from height (h), it reaches ground in 4 s. The height will be.

✓ a) 80 m

b) 100m

c) 60 m

d) 40m.

$h = \frac{1}{2}gt^2$

$= \frac{1}{2}(10)(4)^2 - 16$

$= 10 \times 8 = 80m$

MCQ In projectile motion $\theta = 45°$ and range is 100m. The max height attained will be

✓ a) 25

b) 45

c) 50

d) 80

$4H = R\tan\theta$

$4H = (100)(\tan 45)$

$H = 100/4 = 25$

MCQ. For what angle 20, 35, 50 and 70° the range is maximum for?

a) 20

b) 35

✓ c) 50 (nearest to 45)

d) 70

No: Date:

Unit #3 Work, Energy & Power

Topic #3 (2 MCQ's)

Work, Energy & Power.

By :- Saeeda maryam

→ When object is displaced through some distance after application of Force The work is said to be done.

No: Date:

(a) Understand the concept of work done in term of the product of a force and displacement in the direction of the force

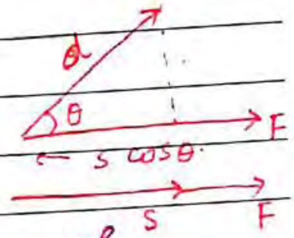
Work:-

The work done by a force in displacing an object is defined as the product of the displacement and the component of force in direction of the displacement is called work.

$W = F \cdot d$ in direction of force.

$W = F \cdot d\cos\theta$

SI ↑ $W = Fd\cos\theta$.



Unit → J, joule. → Nm ↳ SI unit → Torque

cgs → ergs.

$(1J = 10^7 ergs)$

→ The component responsible for motion of object is called $\boxed{F\cos\theta}$ $(F\cos\theta \parallel d)$

→ The component $F\sin\theta$ is perpendicular to displacement.

→ Work is scalar Quantity

Nature of Work Done:-

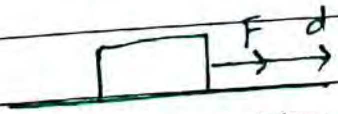
★ Positive Work:-

(i) if $F \parallel d$, $\theta = 0°$

$W = Fd\cos 0°$

$W = Fd(1)$

$W = Fd.$

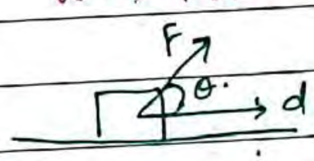


→ along same direction.

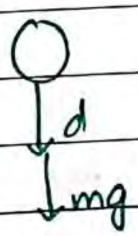
Maximum work.

(ii) if $\theta \leq 0$ then

$W \rightarrow +ve.$



(iii)



$W = Fd\cos 0°$

$W = mgh(1)$

$W = mgh.$

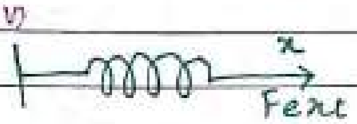
$\boxed{Fd = -Fd}$

$\checkmark -100J = 100J$

*work can ... opposite direction it is scalar quantity.

No: Date:

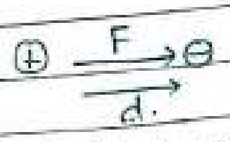
(iv)



$W = Fx\cos 0°$

$\boxed{W = Fx}$ +ve.

(v)



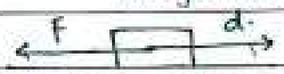
$W = Fed\cos 0°$

$\boxed{W = Fed}$ +ve.

* Negative Work:–

↳ against direction of force.

(i)



$W = Fd\cos 180°$

$W = Fd(-1)$

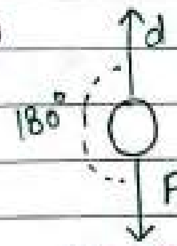
Max -ve work. $\boxed{W = -Fd}$ → -ve.

(ii)

if $\theta > 90$

$W = -Fd$

(iii)

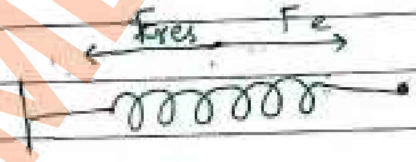


$W = Fd\cos 180°$

$= -Fd$

$= -mgh$.

(iv)



$W = F_{res}\, x\cos 180°$

$W = F_{res}\, x(-1)$

$W = -F_{res}\, x$.

(v)

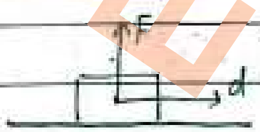
$W = Fd\cos 180°$

$= -Fd$.

(vi) Work done to retarding force is negative.

* Zero Work:–

(i)



$\theta = 90°$

$W = 0$

(Minimum work)

(ii) if $F = 0$ / $d = 0$ then $W = 0$.

(iii) Magnetic field/force does no work.

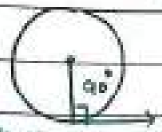
→ deflecting

→ work is related to accelerating.

Imp * +ve work → increase K.E
-ve work → decrease K.E
no work → no change in K.E

No: Date:

(iv) centripetal Force does no work.
↳ because it acts at the centre of circle.



at every Point angle b/w F and d is 90°

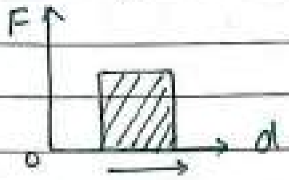
and velocity is along tangent which is called displacement.

$\Delta K.E = 0$.

Graph:-

$W = Fd$.

★ Area under Force displacement Graph gives us work.



★ Work Done by constant Force:-

→ no change in magnitude and direction.

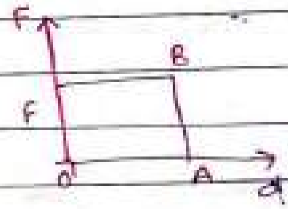
→ distance is covered in direction of force

→ work is a scalar Quantity

$W = \text{Area of rectangle}$

$W = (OA)(AB)$

$= (F)(d)$



★ Work Done by Variable Force:-

→ Work is not in straight line.

Total area $= \sum_{i=1}^{n} F_i \cos\theta_i \Delta d_i =$ work done.

→ Graph → b/w $F\cos\theta$ and d.

★ Work Done in term of unit vector:-

$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1$.

$\hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{k} = \hat{k}\cdot\hat{i} = \cdots = 0$

Conservative Field:-

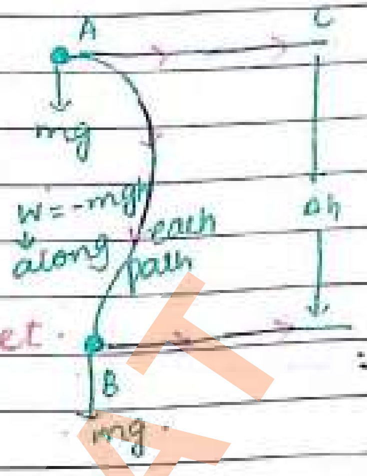
If field satisfies following two conditions it is said to be conservative

→ work done along close path = zero.

→ work done is independent of path followed by body but depend on final and initial position.

No: Date:

e.g. Electric Field.
Gravitational Field.
Spring constt.



Non-conservative Fields:-

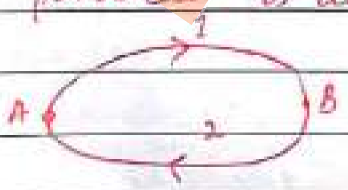
Frictional Force
Propulsion Force on rocket.
Force of motor
Tension in string

* work done by gravity → -mgh
against gravity → +mgh

"Conservative Field and Force has property of storing energy in the system. This energy is P.E of system."

Difference b/w conservative and non-conservative Force.

Conservative Force	Non-conservative Force.
• Work done by these forces in carrying a particle around closed path is zero i.e $W_{total} = 0$	• Work done is not zero $W_{total} \neq 0$
✓ Work Doesn't depend upon path along which particle is displaced	✓ Work done depends upon the path. $W_{AB} \neq W_{BA}$



$W_{AB} = W_{BA}$.

No: Date:

Conservative Force.	Non-conservative Force.
✓ Under these forces the Kinetic energy of particle remains Constt. $K.E_i = K.E_f$	Kinetic Energy of particle changes. $K.E_i \neq K.E_f$
	All these are velocity dependent.
e.g.	e.g.
* central Forces	* Frictional Force.
✓ Gravitational	* Retarding
✓ Elastic	* viscous
✓ Lorentz	* magnetic force due to electric current.
✓ Electrostatic	
✓ Magnetic	

(b) Understand the concept of Kinetic Energy.

Energy:-
→ Ability of body to do work.
→ Units are same as that of work.
→ SI unit → joule.
→ others → foot-pound, erg, kilowatt-hour
→ Types:-
(i) Kinetic Energy
(ii) Potential Energy.

Kinetic Energy:-
→ Energy due to movement/motion is called kinetic Energy.

Relation:-

$$K.E = \frac{1}{2}mv^2.$$

No: Date:

Other relations:-

$\boxed{K.E = \frac{1}{2}(\vec{p} \cdot \vec{v})}$ $P = \sqrt{2mK.E}$

$\boxed{K.E = P^2/2m}$

→ totally depends upon

⇒ $K.E \propto v^2$

↓ speed
magnitude of velocity

Graphically:-

$(K.E \propto v^2)$ v^2 $(K.E \propto P^2)$ P^2 $K.E \propto 1/m$
$m \rightarrow$ constt. $P \rightarrow$ constt.

- For two bodies having equal momentum:- $\frac{K.E_1}{K.E_2} = \frac{m_2}{m_1}$

- For two bodies having equal kinetic energies:- $\frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}}$

(c) Understand the concept of Potential Energy

$P.E = mgh$.

→ The energy possessed by body due to change in its position relative to some reference point.

$\boxed{P.E = mgh}$

$\boxed{E.P.E = \frac{1}{2}kx^2}$

$\boxed{P.E = \frac{GMm}{R}}$

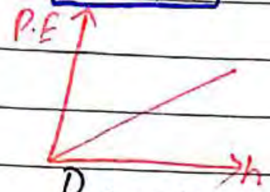
M → mass of earth

R → height.

No: Date:

Graphically:-

$\boxed{P.E \propto h}$



Work-Energy Principle:-

W → ΔK.E, ΔP.E, ΔP.Ee

$$W = \Delta K.E$$

$$F \times S = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$F \times S = \Delta K.E$$

$$\Rightarrow \boxed{F = \frac{\Delta K.E}{S}} \rightarrow \text{slope.}$$

(For conservative forces: $W = \Delta P.E$).

(d) Explain Interconversion of Kinetic Energy and Potential Energy in gravitational field.

Conservation of energy.

→ Energy cannot be destroyed. It can be transformed from one form to another but total amount of energy remains const.

→ When a cup is dropped the P.E changes to K.E. but on striking the ground the K.E changes to heat and sound. but total energy at each instant is always conserved.

$$K.E + P.E = const.$$

No: Date:

Interconversion of K.E and P.E:-

mgh

K.E

→ If a body is dropped from height 'h' to earth's surface in absence of air, then;

Loss in P.E = Gain in K.E

P.E=0

$$mg(h_1 - h_2) = \frac{1}{2}m(v_2^2 - v_1^2)$$

→ if a body is dropped from height 'h' to earth's surface in presence of air then

Loss in P.E = Gain in K.E + work done against air friction.

$$\Delta mgh = \Delta \tfrac{1}{2}mv^2 + fh$$

$$\Rightarrow \Delta K.E = \Delta mgh - fh.$$

→ if a body is thrown vertically upward in gravitational field in presence of air, then;

Imp

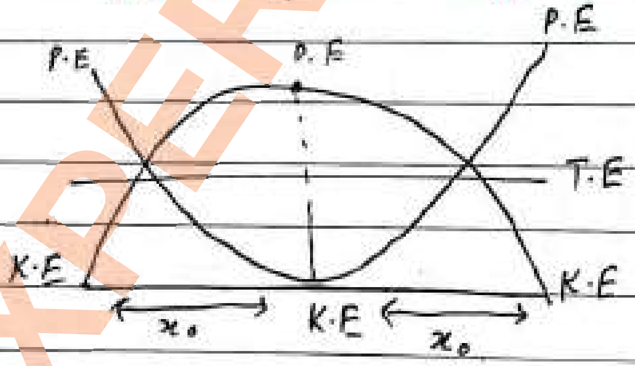
$mgh = \tfrac{1}{2}mv^2$

$2gh = v^2$

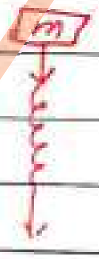
$v = \sqrt{2gh}$

Loss in K.E = Gain in P.E + work done against air.

$$\tfrac{1}{2}mv^2 = mgh + fh.$$



For Spring:-



Loss in P.E = Gain in E.P.E

$$mgh = \tfrac{1}{2}kx^2$$

No:

Date:

(e) Define power in term of work done per unit time and use power as product of Force & velocity.

For moving objects:-

$$P = \frac{W}{t} \rightarrow \Delta K.E/\Delta P.E$$

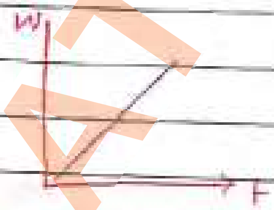
$$P = \frac{K.E}{t}$$

✓ $$P = \frac{\frac{1}{2}mv^2}{t}$$

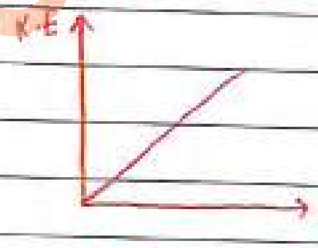
$$P = \frac{mvv}{2t}$$

$$\boxed{P = \frac{1}{2}Pa.}$$

★ The rate of doing work of a body is called power.



⇒ Slope = $\tan\theta = \frac{W}{F} = P$



⇒ Slope = $\tan\theta = \frac{K.E}{t} = P$

✓ SI watt → J/s

✓ cgs → erg/s.

For Height:-

✓ $$P = \frac{mgh}{t}$$

Instataneous Power:-

$$P = \lim_{\Delta t \to 0} \frac{\Delta W}{\Delta t}$$

$$P = \lim_{\Delta t \to 0} \frac{F.d}{\Delta t}$$

⇒ $$P = \vec{F}\cdot\vec{v}$$

Units:-

1kWh = 1000 × 3600

= 3.6×10^6

= 3.6MJ

1Wh = 3.6×10^3 J

3.6 × kJ

1hP = 746 watt

10hP = 7460 watt

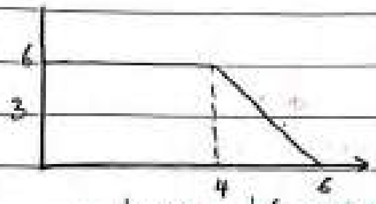
100hp = 7.460×10^4

= 7.46×10^{11} erg/s

= 550 foot pound / sec.

Multiple Choice Questions.

MCQ 2.

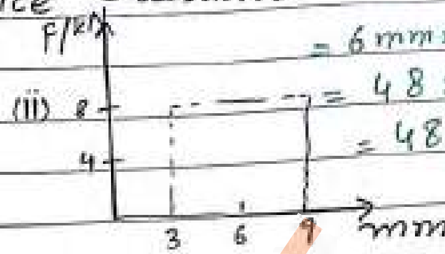


$= 4\times6 + \frac{1}{2}\times2\times6$

$= 24 + 6$

$= 30J$

(ii)

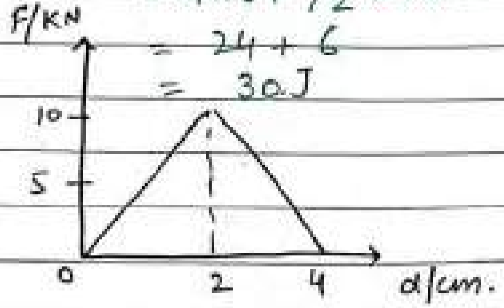


$= 6mm \times 8kN$

$= 48\times10^{3}\times10^{-3}$

$= 48J$

MCQ 3



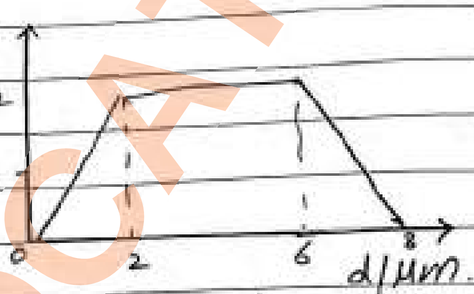
$= \frac{1}{2}\times8\times10 + \frac{1}{2}\times2\times10$

$= 10 + 10$

$= 20\times10^{-2}\times10^{+3}$

$= 200J$

MCQ 4



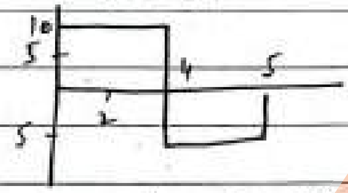
$= \frac{1}{2}\times2\times2 + 4\times2 + \frac{1}{2}\times2\times2$

$= 2 + 8 + 2$

$= 12\times10^{-6}\times10^{3}$

$= 12\times10^{-3}J$

MCQ 5

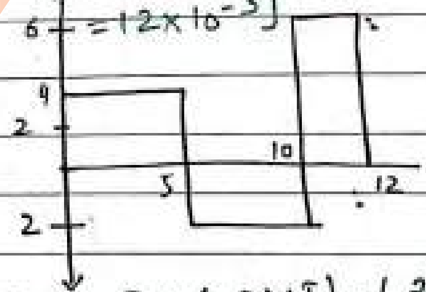


$= 4\times10 + (-5)(1)$

$= 40 - 5$

$= 35$

MCQ 6



$= 4\times5 + (-2)(5) + (2)(6)$

$= 20 - 10 + 12$

$= 32 - 10$

$= 22J$

MCQ $\vec{F} = 2\hat{i} + 6\hat{j}$

$\vec{d} = 4\hat{i} + 3\hat{k}$

$W = \vec{F}\cdot\vec{d}$

$= (2\hat{i} + 6\hat{j})(4\hat{i} + 3\hat{k})$

$= 8 + 0 + 0$

$= 8J$

MCQ $\vec{F} = 2\hat{i} + 3\hat{j} + \hat{k}$

$d = (4, -3, 2)$

$= (2\hat{i} + 3\hat{j} + \hat{k})(4\hat{i} - 3\hat{j} + 2\hat{k})$

$= 8 - 9 + 2$

$= 1J$

No: Date:

MCQ $F = 2\hat{i} + 3\hat{j}$

$r_1 = 2\hat{i} + 3\hat{j}$

$r_2 = 4\hat{i} + 7\hat{j}$

$W = ?$

$\vec{d} = \vec{r_2} - \vec{r_1}$

$= (4\hat{i} + 7\hat{j}) - (2\hat{i} + 3\hat{j}) = 2\hat{i} + 4\hat{j}$

$W = \vec{F} \cdot \vec{d}$

$= (2\hat{i} + 3\hat{j})(2\hat{i} + 4\hat{j})$

$= 4 + 12 = 16\ J$

MCQ Which work is greater

1) -100
2) 100
3) 0
✓ 4) -1000

MCQ $F = 2\hat{i} + \hat{j} - 3\hat{k}$ apply on a body and it moves through displacement of 2m along -ve y-axis, then work done will be:

$W = (2\hat{i} + \hat{j} - 3\hat{k}) \cdot (-2\hat{j})$

$W = -2\ J$

MCQ A car moving along the road of total energy 60kJ and car wastes 45kJ. Find efficiency of car:

$= \frac{60 - 45}{60} \times 100$

$= 1500/60 = 25\%$

MCQ $\vec{F} = (5 + 3x)$ apply on object and it move from $x_1 = 2m$ to $x_2 = 6\ m$ The work done is:

$W = F \cdot d$

$x = x_2 - x_1$

$x = 4m.$

$= (5 + 3x)(4)$

$= 20 + 12x$

$= 20 + 12(4)$

$= 20 + 48 = 68\ J$

No: Date:

* MCQ From the water fall water is falling down at rate of 100 kg/s on turbine of 100m The Power will be

a) 1kW
b) 10kW
c) 100W
✓ d) 100kW

$P = \frac{mgh}{t}$

$= 100 \times 10 \times 100$

$= 100kW.$

MCQ If a bulb uses energy of 100 J and remains on for 25sec. Power consumed will be

✓ a) 4W b) 6W c) 2500W.

MCQ A machine gun fires 240 bullets per minute with $80ms^{-1}$. If mass of each bullet is 0.04 kg, then Power will be:-

a)
b)
c)
d)

$= \frac{\cancel{240}^{12} \times 0.04 \times (80)^2}{\cancel{2} \times 60}$

$= \frac{\cancel{120}^{20} \times 4 \times 6400}{6000}$

$= \frac{480 \times 64}{5160}$

$=$

MCQ If $m_1 : m_2 = 2 : 1$

P constt

Find ratio $K.E_1 : K.E_2 = ?$

1:2 bcz $\frac{K.E_1}{K.E_2} = \frac{m_2}{m_1}$

MCQ If $P_1 : P_2 = 3:2$

K.E constt. then $m_1 : m_2 = ?$

$= 7/2$

$\frac{m_1}{m_2} = \frac{P_1^2}{P_2^2} = \frac{3^2}{2^2} = 9/4$

No: Date:

MCQ If $K.E_1 : K.E_2 = 4:9$

mass ⇒ constt $P_1 : P_2 = ?$

$$\frac{P_1}{P_2} = \sqrt{\frac{K.E_1}{K.E_2}} = \sqrt{\frac{4}{9}} = 2/3.$$

MCQ If $m_1 : m_2 = 4:1$

$K.E$ ⇒ constt $P \propto \sqrt{m}$.

$P_1 : P_2 = ?$

$$\frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{4}{1}} = 2/1$$

MCQ If $v_1 : v_2 = 9:1$

then Find $m_1 : m_2 = ?$

$$\frac{m_1}{m_2} = \frac{v_2^2}{v_1^2} = \frac{1^2}{9^2} = \frac{1}{81}$$

MCQ If $m_1 : m_2 = 9:16$

$K.E$ ⇒ constt

Find $P_1 : P_2 = ?$

$$\frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{9/16} = \frac{3}{4}.$$

* MCQ A ball of 0.2kg thrown vertically upward by applying a force by hand/arm. If arm move 0.2m which is applying the force and ball goes upto 2m height. Find force.

a) 10N
b) 30N
✓c) 20N
d) 40N

$w = mgh$

$F \times S = mgh$

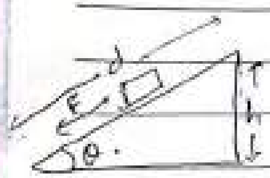
$F \times 0.2 = 0.2 \times 10 \times 2$

$F = 20\,N$

No: Date:

Imp [1 day Food → 1/3 litre
2 day Food → 2/3 Litre.]

MCQ In diagram, which relation is correct for interconversion of energy.



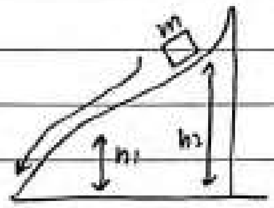
a) $mgh = \frac{1}{2} mv^2 + fh$

✓b) $mgh = \frac{1}{2} mv^2 + fd$.

c) $mgh + fd = \frac{1}{2} mv^2$

d) $mgh - \frac{1}{2} mv^2 = -fd$.

MCQ

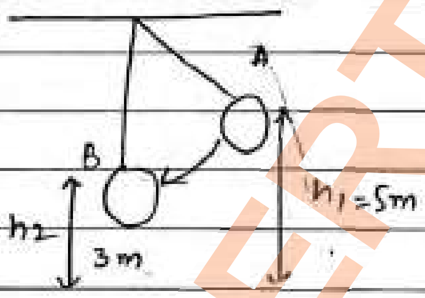


What is relation of speed of block in diagram.

$v = \sqrt{2gh}$

$v = \sqrt{2g(h_2 - h_1)}$

MCQ



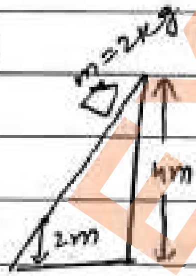
$v = \sqrt{2g(h_1 - h_2)}$

$v = \sqrt{2 \times 10 (5-3)}$

$= \sqrt{2 \times 20}$

$= \sqrt{40} = 2\sqrt{10}$

MCQ



The speed of block from its mean position to mid of inclined plane is

$v = \sqrt{2gh_2 - h_1}$

$= \sqrt{2 \times 10 \times (4-2)}$

$= \sqrt{40} = 2\sqrt{10}$.

No: Date: heat up $\frac{1}{2}mv^2 = mc\Delta T$

MCQ A block of mass 2kg is dropped from the height 40cm on spring. The spring compressed by 10cm. The force constant will be

✓ a) 800N/m $mgh = \frac{1}{2}kx^2$

b) 600N/m

c) 1000N/m.

d) 900 N/m.

MCQ At what distance x P.E is half of K.E.

$$P.E = \frac{1}{2}K.E$$

$$mgh - mgx = \frac{1}{2}mgx$$

$$mgh = \frac{1}{2}mgx + mgx.$$

$$gh = \frac{3}{2}x$$

$$x = \frac{2}{3}h.$$

MCQ A loaded and unloaded bus are both moving with same K.E are stopped by same retarding force such that they cover stopping distance S_1 & S_2. what is ratio of S_1 to S_2.

a) 1:1 $\Delta K.E = \Delta K.E$

b) 1:2 $Fd = Fd$

c) 2:1 $\cancel{F}S_1 = \cancel{F}S_2$

d) can't be predicted. $S_1 = S_2$.

MCQ K.E of object having mass 2kg & velocity $\cos\alpha\hat{i} + \sin\alpha\hat{j}$ will be.

a) 2J ~~b)~~ 1J c) $2\cos\alpha$ J (d) $2\sin\alpha$ J

Angle with x-axis → Fdcosθ
Angle with y-axis → Fdsinθ

lift → work is done.

No: Date:

$K.E = \frac{1}{2}mv^2$
$= \frac{1}{2} \times 2(\cos\alpha \hat{i} + \sin\alpha \hat{j})^2$ $\quad = \cos^2\hat{i} + \sin^2\alpha^2\hat{j} = 1$
$= \frac{1}{2} \times 2(1)$
$= \underline{2J}$

MCQ Light & heavy body have same K.E which one has greater momentum.
✓ a) Heavy
b) Light
c) Both have same
d) None.

$K.E = \frac{P^2}{2m}$

★ MCQ Incorrect unit of work are
a) erg
✓ b) watt
c) newton m
d) J

MCQ The work done by gravity during descent of projectile.
✓ a) +ve
b) -ve
c) 0
d) depends on sign.

MCQ★ not a scalar quantity
a) v, F, P
✓ b) d, a, F
c) a, ~~v~~, W
d) E, W, d.

MCQ

No: Date:

Topic # 4

Circular Motion (2 MCQ's)

By:- Saeeda Mamoon

No: Date:

(a) Describe the angular motion with concept of angular displacement, angular velocity and use relation b/w angular and linear velocity to solve problems.

Circular Motion:-

"Motion of bodies in circular path is called circular motion."

→ During uniform circular motion, the direction of position vector changes but the magnitude remains constant which is equal to r. (radius of circular path)

→ In circular motion, the direction of velocity vector changes continuously but its magnitude remains constant.

→ For one complete revolution, the angular displacement is 2π and time taken is T.

$$\omega = \frac{2\pi}{T}$$

→ Speed, Kinetic Energy and angular momentum remains constant in circular motion.

→ Circular motion may also be called as angular motion.

No: Date:

Angular Quant → Angular displacement, Angular velocity, Angular Acc.

Angular Displacement:- (θ)

"It is the angle swept by the radial line during circular motion of a particle measured from some initial point to some final Point."

- → direction along the axis of rotation
- → determined by right hand rule
- → SI unit → radian.

". angle made by an arc at the centre, whose length is equal to the radius of circle.

$S = r\theta$ $\quad \theta = S/r$

* $1^\circ = \pi/180 \text{ rad} = 0.0174 \text{ rad}$

* $\boxed{1 \text{ rad} = 57.3^\circ}$

** For 1 complete revolution.

$\theta = \frac{2\pi r}{r}$

$= 2\pi \text{ rad}$.

$= 360 \text{ degrees}$

- → Non-SI - "degree" "rev" "cycle"
- → Indicated by θ
- → change in angular position.
- → vector Quantity

Angular Velocity:- (ω)

The rate of change of angular displacement is called angular velocity

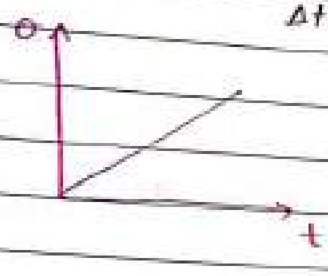
$\omega_{av} = \frac{\Delta\theta}{t}$ $\quad (v = r\omega)$

→ indicated by (ω)

No: Date:

→ unit → rad/s
→ unit → deg/s, rev/s, cycle/s, vib/s.
→ usually not a vector Quantity
→

$\omega_{inst} = \lim_{\Delta t \to 0} \frac{\Delta \theta}{\Delta t}$ (vector Quantity (Always))



(Graph of θ-t gives angular velocity $\vec{\omega}$)

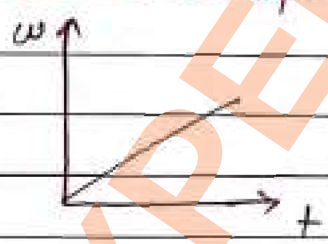
Angular Acceleration:- (α)

→ time rate change of angular velocity is called angular acceleration.

$\vec{\alpha} = \frac{\Delta \vec{\omega}}{\Delta t} = \frac{\omega f - \omega i}{t}$

* $(a = r\alpha)$ Tangential Acceleration

✓ → unit → rad/s^2



→ Slope of ω-t graph gives angular ~~velocity~~ acceleration.

→ Area under ω-t graph gives angular displacement.

☆ Relation b/w Angular & Linear Velocity:-

$v = r\omega$

$\vec{v} = \vec{r} \times \vec{\omega}$

No: Date:

Relation b/w S & θ :-

$$S/r = \theta$$

$$\vec{S} = \vec{\theta} \times \vec{r}$$

Relation b/w a and α :-

$$a = r\alpha$$

$$\vec{a} = \vec{r} \times \vec{\alpha}$$

In these relations all the Quantities are mutually perpendicular to each other in circular motion.

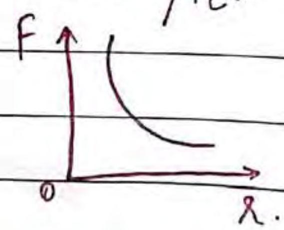
1b) Define centripetal Force and use equation $F = r m \omega^2$, $F = \frac{mv^2}{r}$ and centripetal acceleration equations $a = r\omega^2$ and $a = \frac{V^2}{r}$

" The force required to bend a straight line path of body into circular path is called centripetal force.

→ if centripetal force is removed from the rotating object, it will follow a straight-line motion confined on tangent to the circle.

→ Always acts towards centre of the circle.

$$F_c = \frac{mv^2}{r} \qquad F_c \propto 1/r.$$

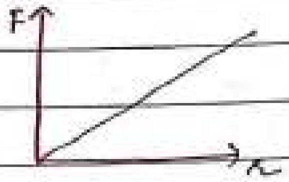


No: Date:

(iii) $F_c = \frac{mv^2}{r}$

$F_c = \frac{m(r\omega)^2}{r} = mr\omega^2$

$F \propto r$



$\leftarrow (\omega \rightarrow const)$

$a_c = \frac{v^2}{r}$

* To be vectorically equal velocities should be in same direction.

moving

$v =$ constant
$\omega \rightarrow$ const
$\tau = 0$.

(iiii) $F_c = mv^2/r$.

$F_c = \frac{2mv^2}{2r}$.

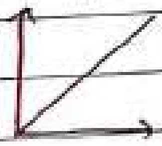
$F_c = \frac{2pv}{2r}$

$F_c = \frac{pv}{r}$.

(iv) $a_c = \frac{v^2}{r}$

$a_c = r\omega^2$

$a_c \propto r$



(v) $F_c = mr\omega^2$

$F_c = mr(2\pi f)^2$

$F_c = mr(4\pi^2 f^2)$

$F_c = 4\pi^2 f^2 mr$.

$F_c = \frac{4\pi^2 mr}{T^2}$

$(F_c \propto 1/T^2)(F_c \propto f^2)$

** Centripetal force can't produce torque:-

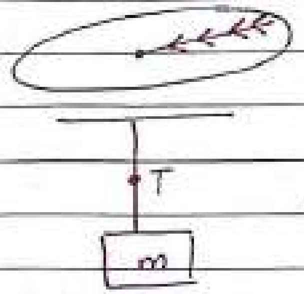
$v =$ const
$\omega =$ const.
$\alpha = \omega/t = 0$
$\tau = I\alpha = I(0)$
$=$ zero.

→ Work done by centripetal force is zero.

→ Centripetal/centrifugal forces form true action/reaction pair but they can't balance each other because they don't act on same body.

No: Date:

Horizontal Circle:-



$T = F_c$

$T = \frac{mv^2}{r}$

Tension in string for horizontal circle

Circular Motion

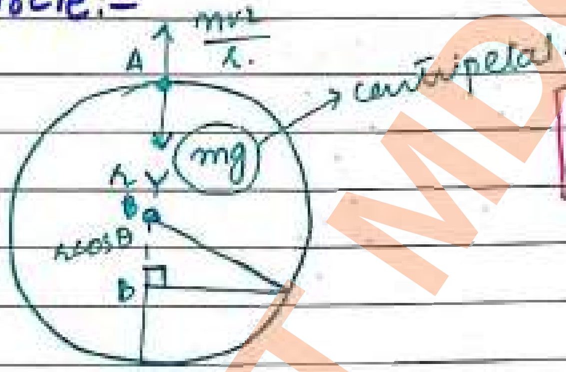
If $a_c = 0$, $a_T = 0$ then $a = 0$ (uniform translatory motion)

If $a_c = 0$, $a_T \neq 0$, $a = a_T$ (non-uniform translatory motion)

If $a_c \neq 0$, $a_T = 0$ then $a = a_c$ (uniform circular motion)

If $a_c \neq 0$, $a_T \neq 0$ then $a = \sqrt{a_c^2 + a_T^2}$ (non-uniform circular motion)

Vertical Circle:-



At Top:-

- Tension is minimum.

$F_c = T + W$

$T = F_c - W$

$T = \frac{mv^2}{r} - mg$

$[\frac{mv^2}{r} \geq mg]$

$T = m(\frac{v^2}{r} - g)$

$T = m(a_c - g)$

$T = ma_c(1 - g/a_c)$

$T = F_c(1 - \frac{g}{a_c})$

No: Date:

At Bottom:-

→ Tension is maximum.

→ $F_c = T - W$

$F = F_c + W$

At minimum:-

$\frac{\cancel{m} v_{min}^2}{r} = \cancel{m} g$

$v_{min}^2 = gr$

$v_{min} = \sqrt{gr}$

$$T = \frac{mv^2}{r} + mg$$

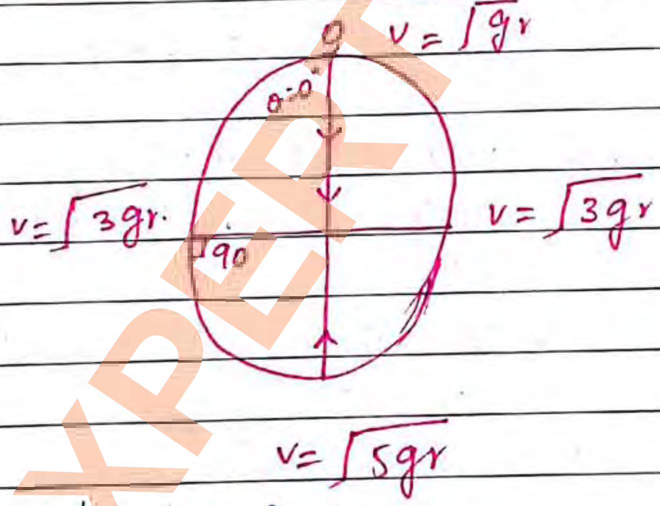
$$T = m(a_c + g)$$

$$T = ma_c\left(1 + \frac{g}{a_c}\right)$$

$$T = F_c(1 + g/a_c)$$

Zero Tension:-

→ If string breaks or mass attached is falling freely then in both cases tension is zero.



In a circular path:-

$$v = \sqrt{3gr - 2gr\cos\theta}$$

$v = \sqrt{5gr}$ ⇒ minimum velocity without which loop cannot be completed.

No: Date:

(C) Understand geostationary orbits.

Geostationary Orbits:-

Orbital Velocity:-

Orbital Velocity for a satellite is $v = \sqrt{\frac{GM}{r}}$. This shows that mass of satellite is not important in describing its orbit.

Artificial / Earth Satellite:-

→ An object revolving around a planet is called satellite

→ An artificial satellite is a space vehicle orbiting the earth in almost circular orbits

→ Moon is natural satellite of Earth.

→ Moon's orbital angular velocity & spin angular velocity are same

→ A man made rocket or spaceship revolving around the earth is called artificial satellite.

→ Artificial satellite revolves around the earth due to force of gravity

→ 100km above the earth the atmosphere is only one-millionth as dense as it is at sea level, and so friction at that height should be negligible.

→ To launch a satellite, it is first carried to the required distance from the earth. Then the satellite is launched in a direction parallel to

Geostationary orbit:-
1- must be directly above equator.
2- All satellites in geostationary orbit have different masses
3- only one possible radius for geostationary

No: Date:

earth's surface with a definite velocity

→ Critical velocity of an artificial satellite is 7.9 kms^{-1}

$$v = \sqrt{gR}.$$

→ Period of satellite is 5060 sec / 84 min.

Geostationary Satellites:—

If time Period of revolution of satellite is equal to time period of earth then satellite will appear stationary from earth It is known as geostationary satellite

Orbital → $v_o = \sqrt{gr} = 7.9 km/s$.

Escap → $v_{esc} = \sqrt{2gr} = 11.2 km/s$

$$v_{esc} = \sqrt{2}\, v_o$$

Formula:—

$$r^3 = \frac{GMT^2}{4\pi^2}.$$

$\boxed{r^3 \propto T^2}$ → Kelper's 3rd law.

$T^2 \propto r^3$

(I) $T \propto r^{3/2}$

(II) $r \propto T^{2/3}$

⇒ Above Pole

$r = 4.2 \times 10^4 km$

⇒ Above Equator.

$r = 3.6 \times 10^4 km$

No: Date:

→ Time Period of geostationary satellite = 24 hours.

→ velocity of G.S.S → 3.08 km/sec.

→ Height of G.S.S from earth → 36000km.

→ Geo-st. sat. from the surface of earth revolves around polar axis of earth.

→ G.S.S is established in an orbit in the plane of equator. As seen from earth the ∴ satellite will always be overheaded a particular place on equator and appear stationary.

→ G.S.S is used for telecommunication weather forecast and other applications.

→ Geostationary satellite appears to remain stationary.

No: Date:

(Multiple Choice Questions)

★ Angular speed of second hand:- *(unit is imp)

$$\omega = \frac{\theta}{t} = \frac{2\pi}{60} = \frac{\pi}{30} \text{ rad/sec} = 1\text{rev/min}$$

★ Angular speed of minute hand:-

$$\omega = \frac{\theta}{t} = \frac{2\pi}{60} = \frac{\pi}{30} \text{ rad/min} = \frac{2\pi}{3600} = \frac{\pi}{1800} \text{ rad/sec.}$$

★ Angular speed of hours hand:-

$$\omega = \frac{\theta}{t} = \frac{2\pi}{12} = \frac{\pi}{6} \text{ rad/hr.}$$

$$\omega = \frac{\theta}{t} = \frac{2\pi}{12\times 60} = \frac{\cancel{2}\pi}{\cancel{720}_{360}} \text{ rad/min} = \frac{\pi}{360} \text{ rad/min.}$$

$$\omega = \frac{\theta}{t} = \frac{2\pi}{12\times 60\times 60} = \frac{2\pi}{43200} = \frac{\pi}{21600} \text{ rad/sec}$$

Equations of Motion:-

(i) $\omega_f = \omega_i + \alpha t$

(ii) $\theta = \omega_i t + \frac{1}{2}\alpha t^2$

(iii) $2\alpha\theta = \omega_f^2 - \omega_i^2$

✓* $\boxed{\begin{array}{l} F = ma \\ \tau = I\alpha \end{array}}$ $\downarrow mr^2$

① WOF acceleration is basically responsible for torque.

a) a_c → bcz F_c don't produce torque.

✓b) a_T

c) α

d) NOT.

No: Date:

② What is direction torque in earth?

a) C.W

b) A.C.W

✓ c) No torque. → in spin motion

→ but exist in orbital motion.

* earth rotate with constant speed.
→ no torque.

③ Radius of geostationary orbit

✓ a) 4.23×10^4 km

b) 4.23×10^6 km

c) 4.23×10^2 km

d) 4.23×10^4 m.

④ The ratio of angular frequency to linear frequency is

✓ a) 2π

b) π

c) $1/\pi$

d) $\pi/2$

$= \frac{\omega}{f} = \frac{2\pi f}{f} = 2\pi.$

⑤ The angle b/w linear velocity and angular velocity of rotating body is

a) 0°

b) 180°

✓ c) 90°

d) 270°

⑥ Time Period of geostationary satellite is

✓ a) 24 hrs

b) 48 hrs

c) 30 hrs

d) 12 hrs.

No: Date:

(7) Force which can do no work on the body which it acts on

a) Frictional

✓b) Centripetal

c) Elastic

d) Gravitational

(8) WOF acc is basically for production of torque

a) α

b) a_c

c) a_T ✓

d) none.

(9) The (ω) of our earth for spinning motion in rad/h.

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{24} = \frac{\pi}{12}.$$

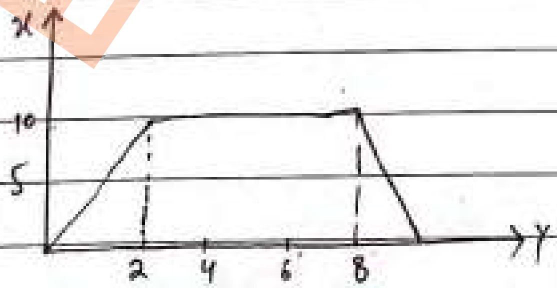
(10) The 'ω' of our earth of orbital motion in radian(days)

$$\omega = \frac{2\pi}{T}$$

$$\therefore = \frac{2\pi}{365}$$

(11) Ex # 5.1 (v. imp).

(12)



Find total number of revolution.

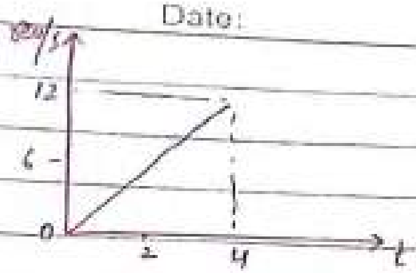
$$\theta = \frac{1}{2} \times 2 \times 10 + \frac{1}{2} \times 2 \times 10 + 4 \times 10$$

$$= 10 + 10 + 40$$

$$= 60 \text{ rev.}$$

No: Date:

(13)

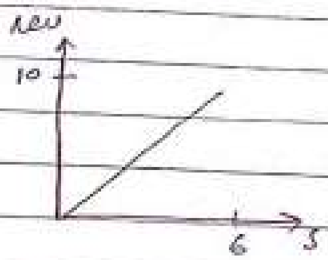


The angular α in rad/s² is

Slop $= \frac{12}{4} = 3$ rev/s²

$= 3 \times 2\pi = 6\pi$ rad/s².

(14)

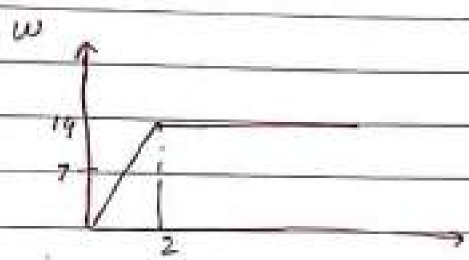


Find ω in SI unit?

$\omega = \frac{\theta}{t} = \frac{10}{6} = \frac{5}{3}$ rev/s.

$= \frac{5}{3} \times 2\pi = \frac{10\pi}{3}$ rad/s.

(15)

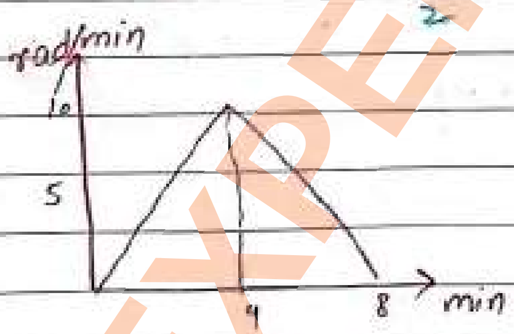


Find α in first two seconds in SI unit.

Slope $= 14/2 = 7$ rev/s²

$= \frac{14}{2} \times 2\pi$ rad/s² $= 14\pi$ rad/s².

(16)



The α for last 4 minutes

$\alpha = \frac{10}{4} = \frac{5}{2} = 2.5$ rad/min²

(17) A body is moving with uniform α.

a) r_1/r_2 c) $\sqrt{\frac{r_2}{r_1}}$ $F_{c1} = F_{c2}$

✓b) r_2/r_1 d) $\sqrt{\frac{r_1}{r_2}}$ $F_c \propto 1/r$

For a complete rotation, the ratio of angular frequency to linear f is.

a) $\pi : 2$
$\boxed{b) 2\pi : 1}$
c) $0.5\pi : 1$
d) all.

$\frac{\omega}{f} = \frac{2\pi f}{f}$
$= 2\pi : 1$

A flywheel gains speed of 540rev/min in 6sec. Its angular acceleration is

$\boxed{a) 3\pi \ rad/s^2}$
b) $2\pi \ rad/s^2$
c) $4\pi \ rad/s^2$
d) $5\pi \ rad/s^2$

$= \frac{540 \times 2\pi}{60 \times 6} = \frac{540\pi}{360}$
$= 3\pi \ rad/s^2$

(18) The angular momentum changes from 2 unit to 6 unit in 4 sec. The torque will be.

$\tau = \frac{\Delta L}{t} = 4/4 = 1.$

(19) In a vertical circle at the top $a_c = 3g$ then $T = ?$

$T = m(a_c - g)$
$= m(3g - g)$
$= m(2g)$
$= 2mg$
$= 2W$

✓a) 2W
b) W/2
c) 4W
d) W/4

(20) In vertical circle at the bottom $a_c = g/2$ then tension will be

$T = m(\frac{g}{2} + g)$
$T = m(\frac{g + 2g}{2})$
$T = m(\frac{3g}{2})$
$T = 3/2 \ mg$
$T = 3/2 \ W.$

✓a) 3/2 W
b) 2/3 W
c) 3 W
d) 2W

(21) If T = 48 hrs, and distance b/w sun and earth becomes 1/4, The new T will be

a)✓ 6 hrs
b) 3hrs
c) 6.5hrs.
d) 9hrs.

$T = r^{3/2}$
$T' = (\frac{r}{4})^{3/2}$
$T' = r^{3/2} \cdot (\frac{1}{4})^{3/2}$
$T' = T(\frac{1}{8})$
$T' = \frac{48}{8} = 6hrs.$

No: Date:

Q27 The distance b/w the sun and earth become 1/9 the original, The new T will be

a) T/6
b) T/27 ✓
c) T/81
d) T/9.

$T \propto r^{3/2}$

$T = \left(\frac{r}{9}\right)^{3/2}$

$T = r^{3/2}\left(\frac{1}{9}\right)^{3/2}$

$T = r^{3/2}\left(\frac{1}{3^2}\right)^{3/2}$

$T = r^{3/2}\left(\frac{1}{3}\right)^{3}$

$T = T/27$

Q23 If r = 4 times of original, the new T will be

a) 8T ✓
b) 6T
c) 7T
d) 2T

$T \propto r^{3/2}$

$T' \propto (4r)^{3/2}$

$T' \propto (4)^{3/2}\ r^{3/2}$

$T' \propto (2^2)^{3/2}\ r^{3/2}$

$T' \propto 2^3\ T$

$T' \propto 8T$

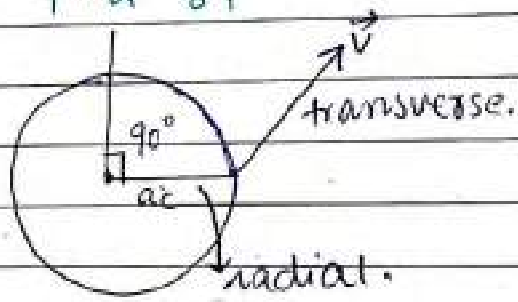
A particle revolves round a circular path with constant speed. The @ is along..

↓

Centripetal acceleration

↓

Along radius.



$T^2 \propto r^3$

$\omega^2 \propto \frac{1}{r^3}$

$\omega \propto \frac{1}{r^{3/2}}$

$r \propto \frac{1}{\omega^{2/3}}$.

No: Date:

Topic-5 Oscillations.

(3 MCQ'S)

By Saeeda Maryam

No: Date:

(a) Define And Explain simple Hormonic motion with examples.

(i) If $a_c = 0$, $a_T = 0$
then $a = 0$ (uniform translatory motion)

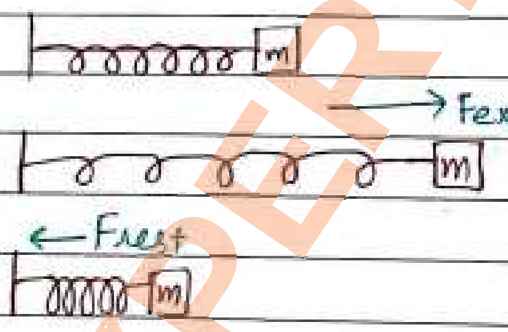
(ii) If $a_c = 0$, $a_T \neq 0$
then $a = a_T$ (non-uniform translatory motion)

(iii) If $a_c \neq 0$, $a_T = 0$
then $a = a_c$ (uniform circular motion)

(iv) If $a_c \neq 0$, $a_T \neq 0$
then $a = \sqrt{a_c^2 + a_T^2}$ (non-uniform circular motion)

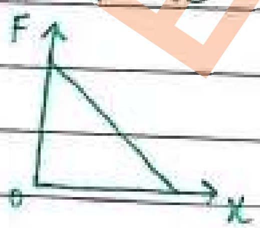
Simple Hormonic Motion.

"To and fro motion of a body about its mean position is called simple Hormonic motion."
↳ repeats after equal intervals of time



$F = -kx$

$F \propto -x$

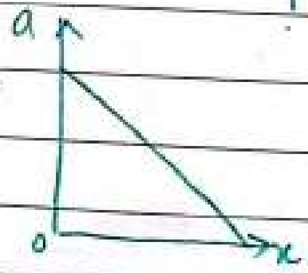


$F = -kx$

$ma = -kx$

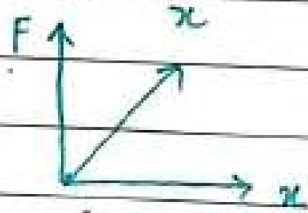
$a = \frac{-kx}{m}$

$a \propto -x$



$\boxed{F = kx}$

$k = \frac{F}{x}$



Slope of Force-ext graph gives k.

No: Date:

$k = F/x$

↳ Nm^{-1} → spring/Force constt.

↳ Dependance

material stiffness.

↳ $k \propto \frac{1}{x} \propto \frac{1}{l}$ l → initial length of spring

k → value doesn't remain constt.

* Simple Harmonic Motion is a special type of vibratory motion in which:
  (i) $a \propto -x$
  (ii) a is directed towards mean position.

→ Restoring Force is always directed toward mean position so termed as restoring by giving a negative sign

Combination of Spring:-

(Formulas are reciprocal to Resistance)

Parallel:-

k_{eq} → equivalent
→ effective

$k_{eq} = k_1 + k_2$.

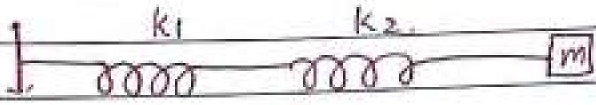
For 'n' numbers of spring having same value of k :-

$k_{eq} = (k_1 + k_2 + - - - + k_n)$

$\boxed{k_{eq} = nk}$

No: Date:

Series:-



$$\frac{1}{k_{eq}} = \frac{1}{k_1} + \frac{1}{k_2}$$

$$\frac{1}{k_{eq}} = \frac{k_2 + k_1}{k_1 k_2}$$

$$k_{eq} = \frac{k_1 k_2}{k_1 + k_2} = \frac{\text{Product}}{\text{sum}}$$

→ For 'n' number of springs:-

$$\boxed{k_{eq} = \frac{k}{n}}$$

(b) Define & use terms amplitude, frequency angular frequency, phase difference. Express the time period in terms of both frequency and angular frequency.

→ Periodic motion is that which repeats itself after equal time intervals.

→ Vibration is one complete round trip of a body about its mean position.

→ Time period is defined as time taken by vibrating body to complete its one vibration.

$$f = 1/T, \quad T = 1/f$$

→ Frequency is number of vibrations per second.

$$f = 1/T$$

→ Amplitude is maximum distance from mean position.

No: Date:

→ Angular Frequency is

$$\omega = 2\pi/T$$

$$\omega = 2\pi f$$

→ Phase is the angle which specifies the displacement & direction of motion of the point executing SHM

i-e $\theta = \omega t$

- Initial angle at $t=0$ is called phase constt and denoted by φ
- If phase constant $\varphi = 90°$

$$x = x_o \sin(\omega t + 90)$$

$$x = x_o \cos \omega t$$

and simple harmonic oscillator starts its SHM from +ve extreme position.

(C) Define and use equations $x = x_o \sin \omega t$, $v = v_o \sin \omega t$, $v = \pm \omega \sqrt{x_o^2 - x^2}$, $a = -\omega^2 x$

Instataneous Displacement ($x = x_o \sin \omega t$):-

$$x = x_o \sin \theta$$

$$x = x_o \sin \omega t$$

(i) At $T/4$:-

$$x = x_o \sin \omega t$$

$$x = x_o \sin\left(\frac{2\pi}{T}\right)\left(\frac{T}{4}\right)$$

$$x = x_o \sin(\pi/2)$$

$$\boxed{x = x_o}$$

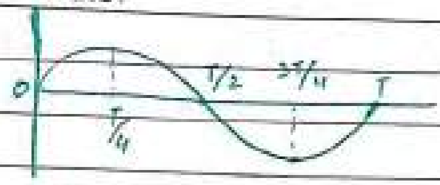
(ii) At $3T/4$

$$x = -x_o$$

(iii) At $\theta = \pi$.

$$x = 0$$

No: Date:



(i) Sinosoidal waveform
(ii) Displacement in a complete vibration is zero.
(iii) Displacement at mean position is zero.
i-e $T/2 \quad T \rightarrow x = 0$

(iv) At Extreme positions $x = x_0$
(v) After one complete vibration, distance covered is $4x_0$.
(vi) For 'n' number of vibration:-
$$\boxed{\text{Distance} = 4n\,x_0}$$

Instataneous velocity $\left(v = \pm \omega \sqrt{x_0^2 - x^2} \right)$

$\Rightarrow v = x_0 \omega \cos\theta$

$\Rightarrow v = \omega \sqrt{x_0^2 - x^2}$

$\Rightarrow v = \omega \sqrt{x_0^2 \left(1 - x^2/x_0^2\right)}$

$\Rightarrow v = x_0 \omega \sqrt{1 - x^2/x_0^2}$

Maximum velocity :-
At Mean:-

$v_0 = \omega \sqrt{x_0^2 - (0)^2}$

$v_0 = \omega x_0$

$\boxed{v = x_0 \omega}$

$v = A\omega$

At Extreme:-

$x = x_0$

$v = \omega \sqrt{x_0^2 - x^2}$

$v = \omega \sqrt{\cancel{x_0^2} - x_0^2}$

$v = \omega \sqrt{0}$

$v = \omega(0)$

$\boxed{v = 0}$

No: Date:

Relation b/w Instataneous & Maximum Velocity:-

$v = \omega\sqrt{x_0^2 - x^2}$

$v = x_0\omega\sqrt{1 - \frac{x^2}{x_0^2}}$

$v = v_0\sqrt{1 - \frac{x^2}{x_0^2}}$

Ratio of Instataneous to Max Velocity:-

$\frac{v}{v_0} = \sqrt{1 - x^2/x_0^2}$

★ Instataneous Acceleration ($a = -\omega^2 x$)

$a = -\omega^2 x$.

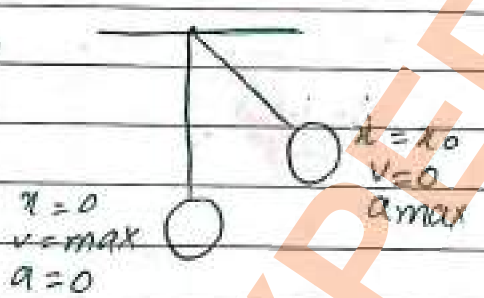
At mean:-

$x = 0$ $\boxed{a = 0}$

At extreme:-

$x = x_0$ $\boxed{a = -\omega^2 x_0}$

Imp →



• Speed of projection is given by:-

$v = \omega\sqrt{x_0^2 - x^2}$

r = radius of circle = amplitude of circle

→ Projection speeds up when moving towards centre of circle

No: Date:

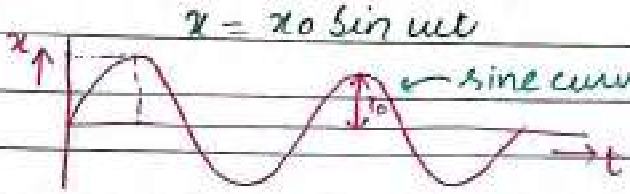
→ Projection slows down when moving away from centre of circle

→ If speed ω of body in circular motion is not const then projection doesn't have SHM but have vibratory motion.

Graphs:-

Displacement-time Graph:-

$x = x_o \sin \omega t$



if $\theta = 0°$

then $x = 0$

Velocity-time Graph:-

$v = x_o \omega \cos \omega t$

if $\theta = 90°$

$v = 0$

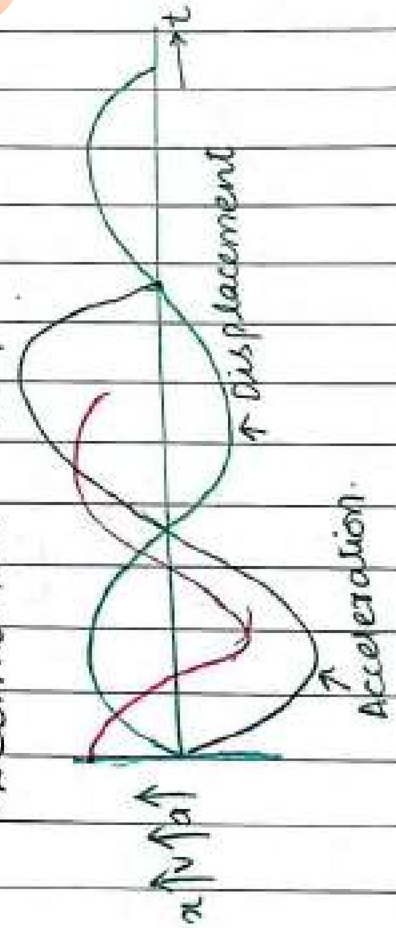
Acceleration-time Graph:-

$a = -\omega^2 x$

if $x = 0$

$a = 0$

* Combined Graph (x–t; v–t & a–t)



No: Date:

Phase Diff :-

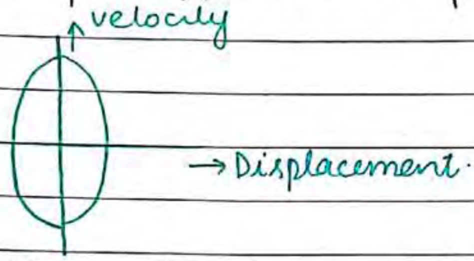
b/w x and v $= 90^\circ$

x and a $= 180^\circ$

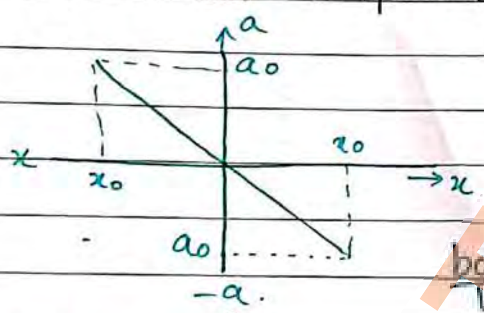
v and a $= 90^\circ$

Velocity Displacement Graph:-

ellipse



Acceleration Displacement Graph:-



$\boxed{a \propto -x}$

Formulas are in 2nd & 4th quadrant → phase diff → 180°.

both ↳ [a → negative max, x → positive max] → must be / vice versa.

Horizontal Mass Spring System:-

↳ due to restoring force & inertia.

→ Hooke's law states that

strain ∝ stress (within elastic limit)

$$F = kx$$

$$k = \frac{F}{x}$$

k ↓ spring constt.

→ If spring is cut into two parts the spring constt of each part is doubled.

All SHM → Periodic
All Periodic → not SHM

No: Date:

$\boxed{T_v = T_H}$

$F = -kx$

$ma = -kx$

$a = \frac{-kx}{m}$ $\boxed{a \propto -x}$

⇒ acc. always directed to mean position

⇒ For a mass spring system $\omega = \sqrt{\frac{k}{m}}$

$\frac{+kx}{m} = +\omega^2 x$

$\omega^2 = \frac{k}{m}$

$\omega = \sqrt{k/m}$

Relation b/w v & v_0 =

$v = \omega\sqrt{x_0^2 - x^2}$

$v = \sqrt{k/m}\sqrt{x_0^2 - x^2}$

$v = x_0\sqrt{\frac{k}{m}}\sqrt{1 - \frac{x^2}{x_0^2}}$

$v = v_0\sqrt{1 - \frac{x^2}{x_0^2}}$

$\frac{v}{v_0} = \sqrt{1 - x^2/x_0^2}$

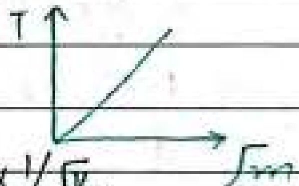
Time Period:-

$T = \frac{2\pi}{\omega}$

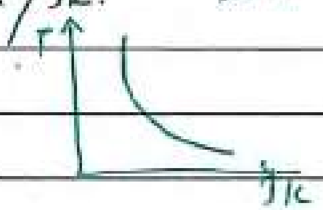
$T = \frac{2\pi}{\sqrt{\frac{k}{m}}}$

$T = 2\pi\sqrt{\frac{m}{k}}$

⇒ $T \propto \sqrt{m}$



⇒ $T \propto 1/\sqrt{k}$.



In case of vertical spring:-

$F = mg$

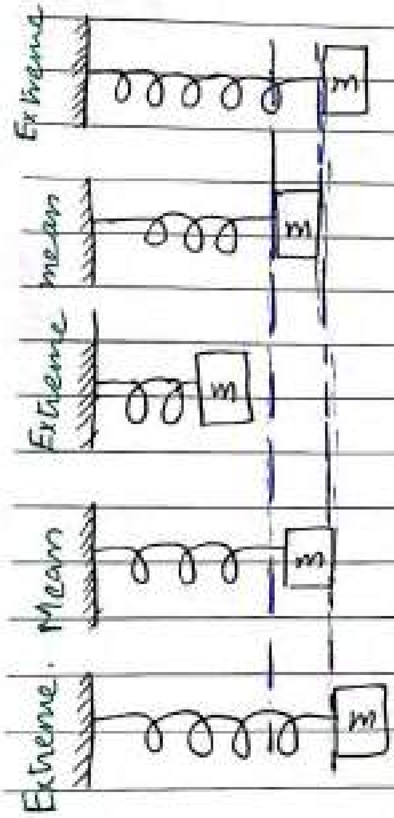
$mg = kx$

$\frac{m}{k} = \frac{x}{g}$

$T = 2\pi\sqrt{\frac{x}{g}}$

No: Date:

Important Information

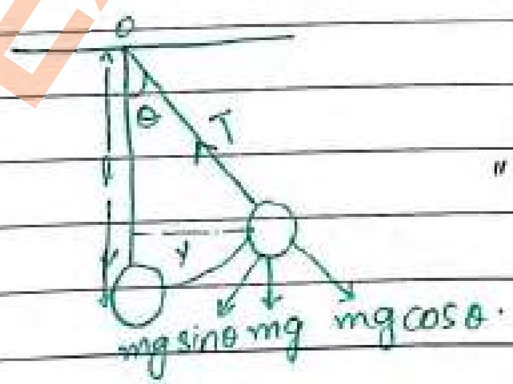


	t	$x(t)$	$v(t)$	$a(t)$	KE	PE
Extreme	0	x_{max}	0	$-a_{max}$	0	PE_{max}
mean	$\frac{T}{4}$	0	$-v_{max}$	0	KE_{max}	0
Extreme	$\frac{T}{2}$	$-x_{max}$	0	a_{max}	0	PE_{max}
Mean	$\frac{3T}{4}$	0	v_{max}	0	KE_{max}	0
Extreme	T	x_{max}	0	$-a_{max}$	0	PE_{max}

→ If horizontal mass spring system is taken to moon, time period remains same.

(d) Understand that motion of simple pendulum is simple Hormonic and use relation

$$T = 2\pi\sqrt{l/g}.$$



"Galileo invented simple pendulum"

No: Date:

→ It consists of a heavy point mass (bob) suspended from a rigid (frictionalless) support by mean of almost weightless & inextensible string.

→ If there is no damping → motion of SP is SHM.
→ Damping force → reduces amplitude & hence motion is stopped finally.
→ In absence of damping force, restoring force is given by:-

$$F_{rest} = -mg\sin\theta$$

→ Tension in the string of Simple Pendulum:-

$$T = mg\cos\theta$$

→ If S.P form angle with horizontal. Both components are reversed.

$$T = mg\sin\theta$$
$$F = mg\cos\theta$$

→ Time Period:-

$$T = 2\pi\sqrt{l/g}$$

→ it is independent of mass & amplitude.
→ Equation of Acceleration for small amplitude is:-

$$a = -\left[g/l\right]x$$

→ Frequency:-

$$f = \frac{1}{2\pi}\sqrt{g/l}$$

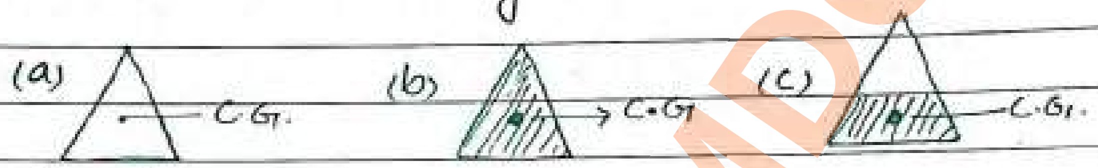
→ If amplitude is not small it don't have SHM as $a = -g\sin\theta$ and $\boxed{\sin\theta = \theta}$ when θ is small.

No: Date:

Pendulum	T	f	l
Simple.	1sec	1Hz	0.25m 25cm $\frac{1}{4}$ m.
Seconds	2sec	f=0.5	0.99/ 1 m 100cm

Concepts

1- Centre of Gravity:-



In elevator.

1- When accelerating Downward:-

$$T = 2\pi\sqrt{\frac{l}{g-a}} \quad T\uparrow \; f\downarrow$$

2- When accelerating upward:-

$$T = 2\pi\sqrt{\frac{l}{g+a}} \quad T\downarrow \; f\uparrow$$

3- When moving upward/downward uniformly:-

$$T = 2\pi\sqrt{\frac{l}{g \pm a}}$$

$$a = 0$$

$$T = 2\pi\sqrt{l/g} \quad \text{(remains same)}$$

No: Date:

4- Elevator is falling freely:-

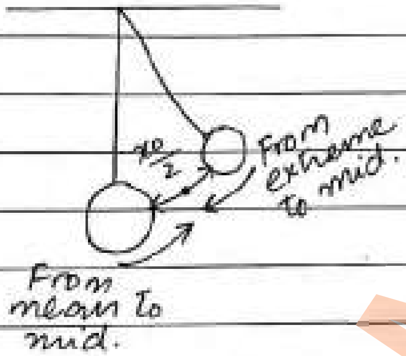
$a = g$

$$T = 2\pi\sqrt{\frac{l}{g-a}}$$

$$T = 2\pi\sqrt{\frac{l}{g-g}} \Rightarrow T = 2\pi\sqrt{\frac{l}{0}} \Rightarrow T = \infty$$

$f = 0$

5-



(a) When Pendulum move to mid from mean:-

$x = x_0 \sin \omega t$

$\frac{x_0}{2} = x_0 \sin \frac{2\pi}{T} t$

$\sin^{-1}\left(\frac{1}{2}\right) = \frac{2\pi}{T} \times t$

$t = \frac{\pi}{6} \times \frac{T}{2\pi}$

$t = \frac{T}{6 \times 2}$

$\boxed{t = \frac{T}{12}}$

(b) When Pendulum moves to mid from extreme.

tak angle with horizontal

so.

$x = x_0 \cos \omega t$.

$\frac{x_0}{2} = x_0 \cos \omega t$

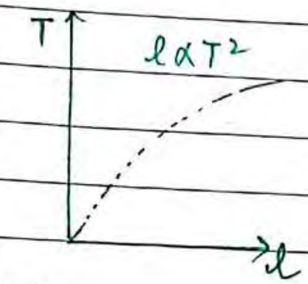
$\cos^{-1}\left(\frac{1}{2}\right) = \frac{2\pi}{T} \times t$

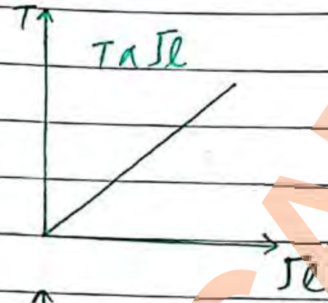
$t = \frac{\pi}{3} \times \frac{T}{2\pi}$

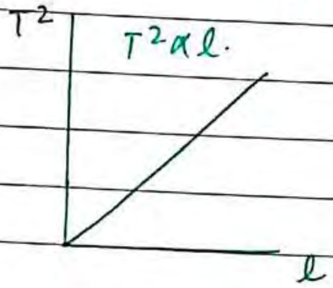
$\boxed{t = \frac{T}{6}}$

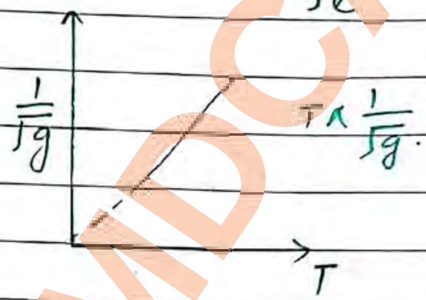
Various Graphs of simple pendulum:-

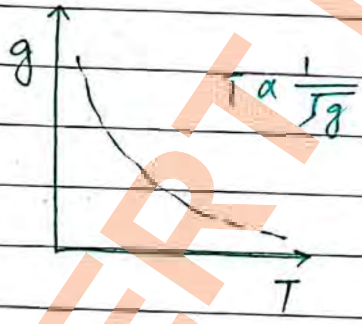
$$T = 2\pi\sqrt{l/g}.$$











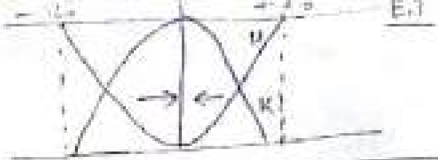
(e) Desribe the interchange between Kinetic energy and Potential Energy during Simple Hormonic Motion.

Energy conservation in SHM:-

- Its K.E is given as:-

$$K.E_{inst} = \frac{1}{2}kx_0^2\left[1 - \frac{x^2}{x_0^2}\right]$$

$$K.E_{max} = \frac{1}{2}kx_0^2 \quad \text{(At mean)}$$



No: Date:

$K.E_{min} = 0$ (At extreme)

$$K.E_{inst} = K.E_{max}\left[1 - \frac{x_p^2}{x_0^2}\right]$$

Exam

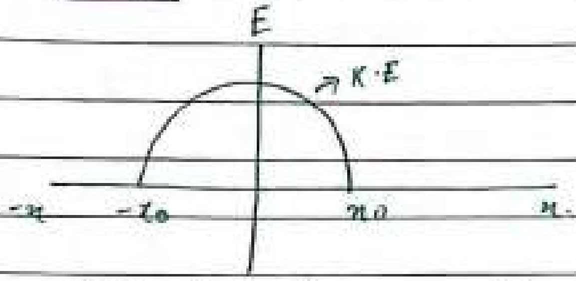
$\therefore k = m\omega^2$

$k = m(2\pi f)^2$

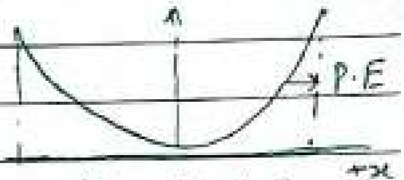
$k = m4\pi^2 f^2$

$k = 4m\pi^2 f^2$

Graph



• Potential Energy is given by:-



Potential Energies.

$P.E_{inst} = \frac{1}{2}kx^2$

$P.E_{max} = \frac{1}{2}kx_0^2$ (At extreme)

$P.E_{min} = 0$ (mean position)

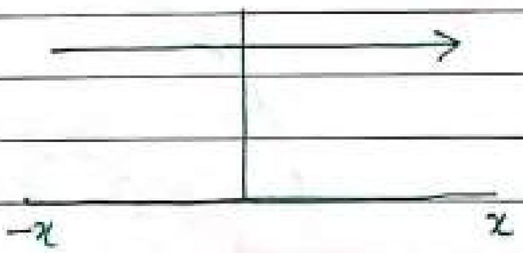
Total Energy:-

$T.E = \frac{1}{2}kx_0^2$

$$K.E_{inst} = P.E_{max}/K.E_{max}/T.E\left[1 - \frac{x^2}{x_0^2}\right]$$

Instantaneous energies $\propto x^2$.

Max energies $\propto x_0^2$



Total Energy.

No: Date:

(f) Define free, forced & damped oscillation with practical examples.

Free & Forced Oscillations:-

Free. → Oscillation of system is called free vibrations if it oscillates without the interference of an external force.

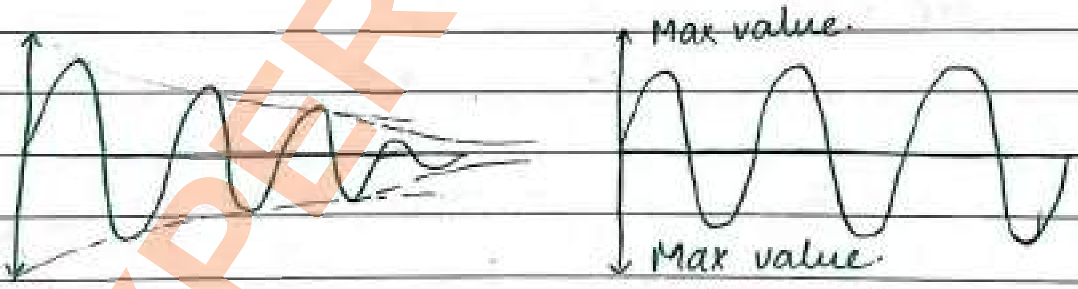
→ Frequency of free oscillation is called natural frequency

Forced → When a system performs oscillation in presence of external periodic force, it is called forced oscillation.

→ A physical system undergoing forced vibration is called driven harmonic ossilator.

Damped Oscillations:-

Such oscillations in which the amplitude decreases steadily with time are called damped oscillations.



Damped. undamped.

No: Date:

(8) Understand the concept of resonance, its advantages & disadvantages.

Resonance:-

A phenomenon of increase in amplitude of a body (capable of vibrating) under the action of a periodic force whose time period is equal to natural time period of body.

OR.

Specific response of a system to external periodic force whose T.P is equal to natural time period.

OR.

Process in which one body transfers its vibration to nearby body whose natural time period is agreeable to it.

- For tuning circuit of TV or radio or mobile phone, (electrical resonance) takes place at frequency

$$f = \frac{1}{2\pi\sqrt{LC}}$$

- Magnetic Resonance Imaging is a resonance phenomenon using radio frequency. It is less damaging than x-rays imaging process.

→ Suspension bridge (Mechanical Resonance) may break down due to vibration with increased amplitude caused by resonance.

No: Date:

→ We get tired on walking because of forced oscillations fed into our legs for resonance.

→ loose parts of car produce noise at specific speed due to resonance.

Sharpness of Resonance:-

- Amplitude → dec with damping force.
  → remain const with un-damped force.

smaller the damped force.
Sharper is resonance.

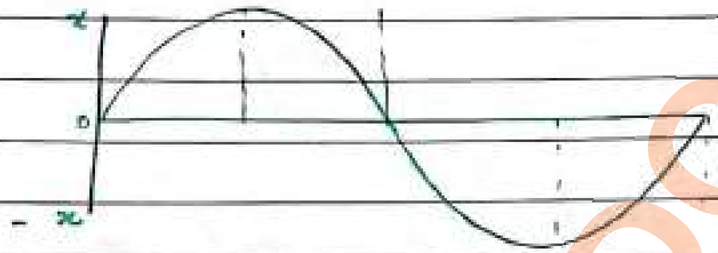
Microwave oven
→ Electrical Resonance
→ $f = 2450 MHz$
$\lambda = 12 cm$.

$$\text{Damping} \propto \frac{1}{\text{density}}$$

No: MCQ's Date:

- For SHM what is essential
  → Restoring F
  → Inertia.

- What is angle b/w acc and displ in SHM
  a) 0° ✓c) 180°
  b) 90° d) 270°



0	$\frac{T}{4}$	$\frac{T}{2}$	$\frac{3T}{4}$	T
0	$\frac{\pi}{2}$	π	$\frac{3\pi}{2}$	2π.
0	$\frac{\lambda}{4}$	$\frac{\lambda}{2}$	$\frac{3\lambda}{4}$	λ

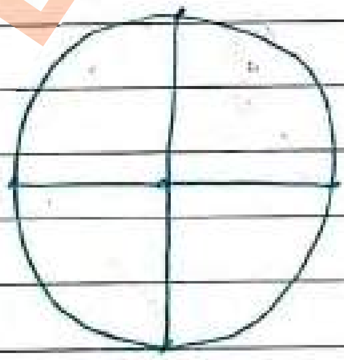
Phase:-

$$x = x_o \sin(\theta + \phi)$$

If P starts from mean $x=0$

$x = x_o \sin(\theta + 0)$

$x = x_o \sin\theta$.



If P starts from mean position $x=0$

$x = x_o \sin(\theta + 180)$

$x = -x_o \sin\theta$.

If P starts from extreme position:-

$x = x_o$

$x = x_o \sin(\theta + 90)$

$x = x_o \cos\theta$

If P starts from extreme position $x = x_o$

$x = x_o \sin(\theta + 270)$

$x = -x_o \cos\theta$.

No: Date:

MCQ's ① A vertical mass spring system is taken from earth to planet where value of g is $g/5$ what will be new expression for time period.

× a) $T' = \sqrt{5}\,T$
× b) $T' = 25T$
× c) $T' = \sqrt{5}$
× d) $T' = \frac{T}{\sqrt{5}}$

✓ $T' = T$

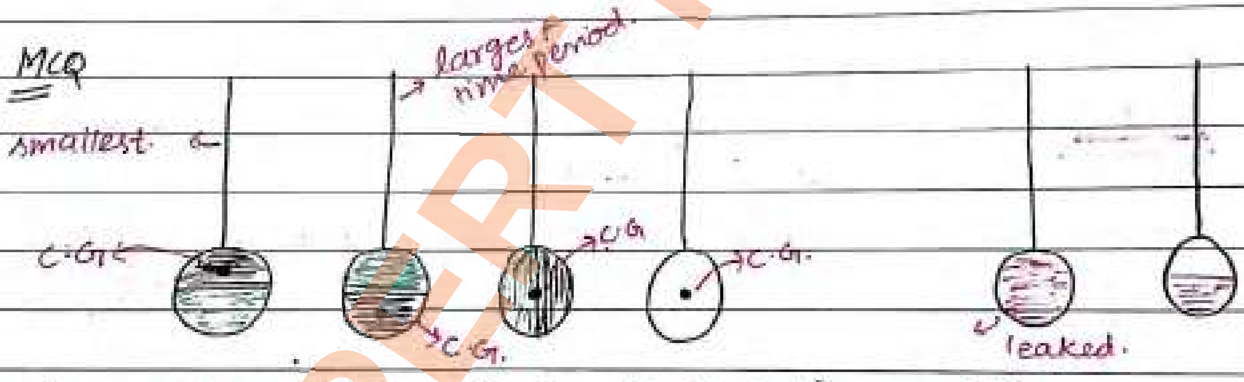
because with increase in gravity x will also change to $x/5$

MCQ ② If simple pendulum ~~is~~ taken to moon.

$$T' = \sqrt{6}\,T.$$

Length of simple Pendulum on moon. = L
" " second's Pendulum " " = $L/6$

MCQ



$l \to$ From suspended point to centre of gravity

⇒ When bob is leaked. filled with water.
C.G → ↓ T.P → increase.
Then → decrease.
T.P → increase
and come to a const value.

No: Date: Exercise.

1. In SHM, the restoring Force must be proportional to
a) Amplitude c) velocity
b) Frequency ✓d) displacement

2. An oscillatory motion must be SHM if
a) amplitude is small
b) P.E = K.E
c) motion is along the arc of circle.
✓d) acc. varies sinosoidally with time.

3. A particle is in SHM with time Period T, At time t = 0 is at equilibrium point. OF the following times at which time is at farthest from equilibrium point.
a) 0.5 T
✓b) 0.7T
c) T
d) 1.5T.

4- An object is undergoing SHM. Throughout a complete cycle its:
a) speed is constt c) Period is varying
b) amplitude is varying d) ✓ acc is varying.

5- An object attached to one end of a spring makes 20 vibrations in 10s. Frequency is
✓a) 2Hz c) 0.05Hz
b) 10s d) 2s.

Date:

6- Frequency and angular Frequency are related by

a) $f = \pi\omega$ c) $f = \omega/\pi$ $\omega = 2\pi f$

b) $f = 2\pi\omega$ ✓ d) $f = \omega/2\pi$

7- A weight suspended from an ideal spring oscillates up and down with Period T. If amplitude of the oscillation is doubled. the time Period will be:

✓ a) T

b) 1.5T

c) 2T

d) T/2.

8. In SHM, the magnitude of acceleration is greatest when.

a) displacement is zero.

b) displacement is max ✓

c) speed is max.

d) force is zero.

No: Date:

Topic#6

Waves.

By

Saeeda Maryam

No: Date:

Wave:-

Wave is due to disturbance created in a medium.

→ Waves transport energy without transporting matter.

→ Waves transfer energy & momentum.
↳ light → photon move [m, v]

Classification:-

Classification of Waves.

Visible waves
→ water waves
→ string waves.

invisible waves.
→ sound waves
→ matter waves
→ radio & TV waves.

Waves (on basis of nature)

Mechanical waves (progressive)
→ require medium for propagation.
e.g sound waves
string waves
water waves

Electromagnetic waves.
Don't require medium for propagation.
e.g radio waves
Heat waves
Light waves.

speed of EMW:- $c = \frac{1}{\sqrt{\mu_o \epsilon_o}}$

Transverse waves.
every part ⊥ to mean

Longitudinal waves. (compressional)
Along the mean.

Water waves are both longitudinal & transverse.

No: Date:

(Q) Describe progressive waves & use relation $v = f\lambda$

Travelling wave is that which propagates or distributes its pulses in space along specific direction. e.g.

(a) waves on a string
(b) waves on a water surface

Periodic Waves:-

Periodic waves are those which are repeated in regular intervals of time.

→ They may be transverse or longitudinal.

For transverse waves:-

the displacement of medium is perpendicular to the direction of propagation wave.

e.g. A ripple in a pond
A wave on a string

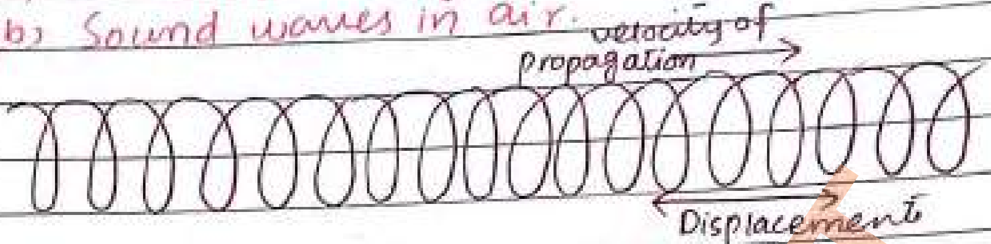
→ They cannot propagate in a gas/liquid. because there is no mechanism for driving motion perpendicular to propagation of the wave.

For longitudinal waves:-

In longitudinal waves, the displacement of medium is parallel to propagation of waves.

No: Date:

e.g (a) wave in a slinky
(b) Sound waves in air.



In fluids, transverse waves die out very quickly and cannot be produced at all.

Transverse Periodic Wave:-

- In a time interval equal to time period, a particle in the wave travel a distance equal to wavelength.
- For all waves $v = f\lambda$
- The particle in the wave separated by a distance which is integral multiple multiple of λ i.e $n\lambda$ are in phase motion each other.
- The particles separated by a distance which is odd multiple of λ i.e $[n+\frac{1}{2}]\lambda$ are out of phase to each other.

(b) Define and explain transverse & longitudinal waves.

Wave:-

The propagation of disturbance in medium with a fixed velocity without changing its form is known as wave.

No: Date:

Wave Motion:-

It is a phenomenon in which a disturbance propagate without transferring or affecting the medium.

→ energy and momentum are transferred from one point to other by propagating wave.

Classification:-

(a) Mechanical Waves

(b) Electromagnetic Waves.

Mechanical:-

↳ elastic & continuous medium is required for their propagation.

e.g sound waves

waves produced on spring

waves produced in water

→ They may be longitudinal/transverse

↓ show polarization.

Electromagnetic:-

↳ don't require medium.

e.g light waves

radio waves

γ-rays

X-rays.

→ They are only transverse

→ Show polarization.

On the basis of vibration:-

(a) Transverse Waves

(b) Longitudinal waves

No: Date:

(a) Transverse waves:-

→ Particles of medium vibrate at right angle to direction of propagation.

→ Crest & trough are produced.

→ liquid surface has property of surface tension which resists any deformation of shape

→ not produced in Gases.

(b) Longitudinal waves:-

→ particles of medium vibrate along the direction of propagation.

→ compression & rarefaction are produced

→ Possible in all media

Charactristics of wave motion:-

Frequency:-

The number of waves produced / passed a point per unit time is called as frequency of wave motion.

Wavelength:-

Shortest distance b/w two consecutive points in same phase

Time Period:-

Time taken to complete one vibration

Amplitude:-

Max. displacement of a vibrating body from mean position is called amplitude

No: Date:

Wave velocity:-
The distance travelled by wave in one second.
→ velocity of particles of medium is different from velocity of wave.

$v = f\lambda$

$$\boxed{\frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}}$$

(c) Define stationary waves and determine wavelength of sound in air columns for open and closed pipe and in stretched string using stationary waves.

Superposition of waves:-
If two or more waves propagate simultaneously in a medium then the resultant displacement is given by vector sum of displacement due to individual waves.

$$\vec{Y} = \vec{Y_1} + \vec{Y_2} + \vec{Y_3} + \cdots + \vec{Y_n}.$$

Different Phenomenon of Superposition:-
Interference:- Two waves having
same frequency
travelling in same direction.

Beats:-
slightly different frequencies
travelling in same direction.

Stationary waves:-
equal frequency opposite direction.

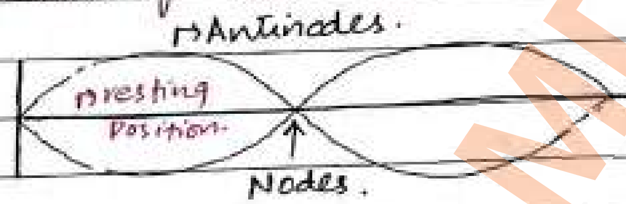
No: Date:

Stationary Waves:-

Superposition of two identical waves travelling opposite to each other in the same medium, simultaneously, gives rise to stationary waves.

→ Both constructive & destructive interference takes place in the formation of stationary waves.

→ Points of constructive Interference → antinodes
→ Points of destructive Interference → nodes.



Nodes	Antinodes.
Amplitude is minimum	Amplitude is max
stationary points	Points that vibrate with max amplitude.
destructive Interference	constructive Interference.
In phase.	out of phase.
max. K.E	max. P.E.
more in number	less in number.
Maximum stress	Minimum Stress.

Distance b/w consecutive node & antinode = $\lambda/2$
Distance b/w a node & antinode = $\lambda/4$.

No: Date:

Modes of transverse stationary waves in a stretched strings:-

→ vibration of thin, long & perfectly elastic string → transverse stationary

→ At both ends → nodes.

→ In middle → antinode.

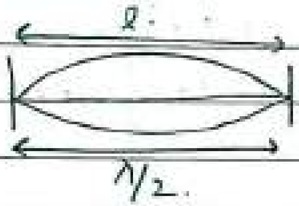
→ Speed of transverse wave:-

$$v = \sqrt{T/m}$$

T → Tension

m ↳ mass per unit length.

Modes of vibration:-



$l_1 = \lambda_1/2.$

$\lambda_1 = 2l_1$

$f_1 = \dfrac{v}{\lambda_1}$

$f_1 = \dfrac{v}{2l_1} \quad \because v = \sqrt{\dfrac{T}{m}} \qquad f_1 = \dfrac{1}{2l}\sqrt{\dfrac{T}{m}}$

→ Fundamental note

→ First Hormonic.

→ zero overtone.

$l_2 = \dfrac{\lambda_2}{2} + \dfrac{\lambda_2}{2} \qquad f_2 = \dfrac{v}{l}$

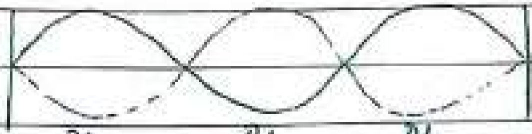
$l_2 = \lambda_2 \qquad f_2 = \dfrac{2v}{2l}$

$\lambda_2 = l_2 \qquad \boxed{f_2 = 2f_1}$

→ First overtone

→ 2nd hormonic.

No: Date:



$$l_3 = \frac{\lambda}{2} + \frac{\lambda}{2} + \frac{\lambda}{2}.$$

$$l_3 = \frac{3\lambda_3}{2}$$

$$\lambda_3 = \frac{2l}{3}$$

$$f_3 = \frac{v}{\lambda}$$

$$f_3 = \frac{3v}{2l} \rightarrow \boxed{f_3 = 3f_1}$$

→ third hormonic
→ 2nd overtone

→ Both odd and even hormonics are emitted from stretched string.

$$\boxed{\lambda_n = \frac{2l}{n}}$$

$$\boxed{f_n = \frac{nv}{2l}}$$

Stationary Waves in Air Column:-

- An organ pipe is a pipe that sets in vibration the air enclosed in it when air is blown into it. As a result sound is produced in it.
- Organ pipes are of two types
  → closed end organ pipe

No: Date:

→ open end organ pipe.

An open end organ pipe has both its ends open.

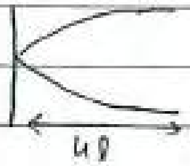
A close end organ pipe has one its ends closed and the other open

Closed end → node

open end → antinode.

Longitudinal stationary waves → in an organ pipe

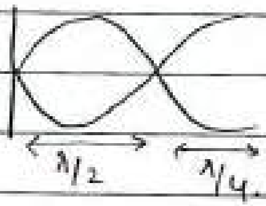
Resonance In closed end organ pipe:-



$l = \lambda/4$

$\lambda_1 = 4l.$

$f_1 = \frac{v}{4l}.$ (Fundamental/ First Hormonic)

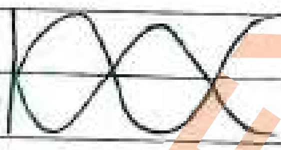


$l = \frac{3\lambda_2}{4}$

$\lambda_2 = \frac{4l}{3}.$

$f_2 = \frac{3v}{4l}.$

$f_2 = 3f_1$



$l = \frac{5\lambda_3}{4}$

$\lambda_3 = \frac{4l}{5}$

$f_3 = \frac{5v}{4l}$

$f_3 = 5f_1$

No: Date:

→ only odd hormonics are produced in closed organ pipe.

$f = 1, 3, 5, \ldots$

$$\boxed{f_n = \frac{nv}{4l}}$$

Relation of fo and fc:-

$$f_c = \frac{v}{4l}$$

$$f_c = \frac{v}{2(2l)}$$

$$f_c = \frac{f_o}{2}$$

$$\boxed{f_o = 2f_c}$$

* Relations for organ pipen open at both ends are same as for stationary ~~stretched waves.~~ string.

Parameter.	Stretched string	Open at both ends	open at one end.
Fundamental.	$f_1 = v/2l.$	$f_1 = v/2l.$	$f_1 = v/4l.$
2nd Hormonic (1st overtone)	$f_2 = 2f_1$ $f_2 = v/l$	$f_2 = 2f_1$ $f_2 = v/l$	$f_1 = 3f_1$ $f_2 = 3(v/4l)$
3rd Hormonic (2nd overtone)	$f_3 = 3f_1$ $f_3 = 3v/2l$	$f_3 = 3f_1$ $f_3 = 3v/2l.$	$f_3 = 5f_1$ $f_3 = 5v/4l.$
Ratio of Hormonics	1:2:3:- - - - (both even, odd)	1:2:3:- - - - (Both even odd)	1:3:5:- - - - . (odd)
Ratio of overtone	2:3:4:- - -	2:3:4:- - - .	3:5:7:- - - - .
	Transverse stationary	Longitudinal Stationary	Longitudinal Stationary

No: Date:

(d) Describe Doppler's Effect and its causes, recognize the application of Doppleris Effect.

Doppler's Effect:-

↳ Applicable for sound waves + light, some EMW

↳ doesn't depend upon distance b/w object & observer → just give result.

Case 1 Observer $\xrightarrow{\text{towards}}$ St. Source

$$f_A = \left(\frac{v+u_o}{v}\right) f \quad f\uparrow$$

$$\lambda_A = \left(\frac{v}{v+u_o}\right) \lambda \quad \lambda\downarrow$$

Case 2 Observer $\xleftarrow{\text{away}}$ St. Source

$$f_B = \left(\frac{v-u_o}{v}\right) f \quad f\downarrow$$

$$\lambda_B = \left(\frac{v}{v-u_o}\right) f \quad \lambda\uparrow$$

Case 3 Source $\xrightarrow{\text{towards}}$ St. observer

$$f_C = \left(\frac{v}{v-u_s}\right) f \quad f\uparrow$$

$$\lambda_C = \left(\frac{v-u_s}{v}\right) f \quad \lambda\downarrow$$

Case 4 Source $\xleftarrow{\text{away}}$ St. observer

$$f_D = \left(\frac{v}{v+u_s}\right) f \quad f\downarrow$$

No: Date:

$$\lambda_D = \left(\frac{v+u_s}{v}\right)\lambda \quad \lambda\uparrow$$

If observer & source are moving towards each other:-

$$f' = \left(\frac{v+u_o}{v-u_s}\right)f$$

$$\lambda' = \left(\frac{v-u_s}{v+u_o}\right)\lambda$$

If observer and source are moving away from each other.

$$f'' = \left(\frac{v-u_o}{v+u_s}\right)f$$

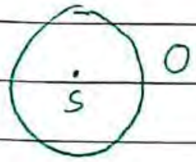
$$\lambda'' = \left(\frac{v+u_s}{v-u_o}\right)\lambda$$

No: Date:

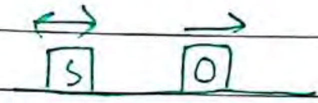
Cases when $f' = f$ or $\Delta f' = 0$
Appearent = original

(1) 

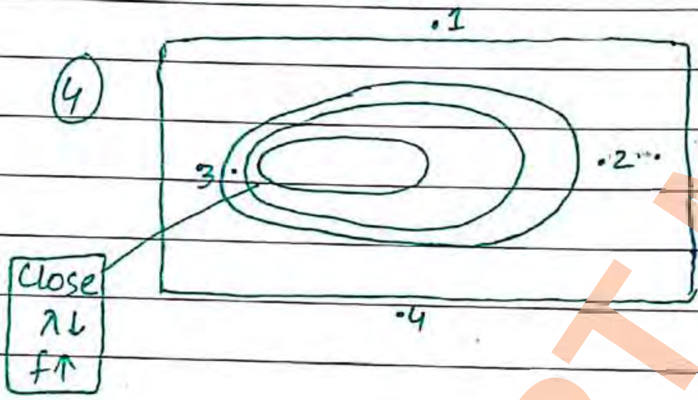
(Both are at rest)

(2) 

If source moving in circular path is moving around observer or vise versa

(3) 

$3\,ms^{-1}$ $3\,ms^{-1}$

(4) 

⇒ speed of sound in water is more than air.
↳ lighter
↳ rare.

⇒ ultrasound
↳ to remove air spaces.

Applicatication:-

(i) → Ships and submarine (sonar devices)
(ii) → Bats (for traveling)
(iii) → Radar (for detection)
(iv) → Determining velocity of a star w.r.t earth.
(v) → To monitor blood flow in major arteries

- When a star is moving away from Earth then wavelength of light increases and red shift of spectrum is observed.

No: Date:

- When a star is moving towards the Earth the wavelength of light decreases and blue shift of spectrum is observed.

No: Date:

Topic #7

Light

(02 MCQ'S)

By Saeeda Maryam

No: Date:

Light :-

Nature → Transverse
→ can be polarized
→ can be reflected
→ can be diffracted
→ can be refracted.
→ can interfere.
→ can be scattered
→ can be dispersed.
→ can be miraged.

The blue colour of sky seems to be blue due to

scattering $\propto 1/\lambda^4$

The twinkling of stars is due to

non-uniformity of our atmosphere

Diamond shines due to T.I.R.

Light waves are less diffracted than sound waves

$\uparrow$ Bending → $\uparrow$ wavelength.

$\downarrow$ Bending → $\downarrow$ wavelength.

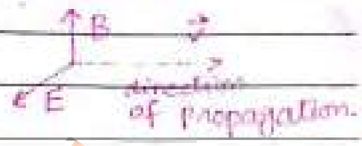
Colourful spectrum of an oil is due to interference.

Red colour
Absorb energy
don't reflect energy

No: Date:

Light consist on Electromagnetic waves.

(a) Define & Explain interference of light waves with constructive and destructive interference.



(Interference)

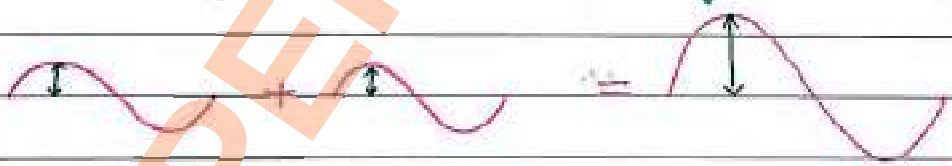
Interference is the superposition of two light waves of same frequency, same phase travelling in same direction in the same medium.

Types:-

(i) Constructive Interference.
(ii) Destructive Interference.

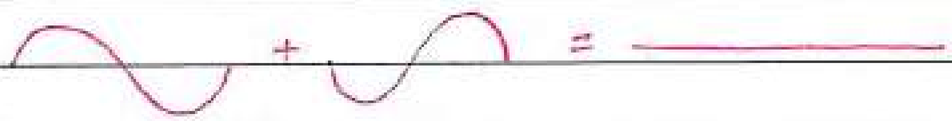
Constructive Interference:-

When two waves meet in such a way that their crests line up together, it is called constructive interference.
→ The resulting wave has a highest amplitude.



Destructive Interference:-

The resultant of two waves of equal frequency and opposite phase resulting in their cancellation when crest of one meet the trough of other is called destructive inteference.



No: Date:

Constructive

Points are in phase.

Path difference $= n\lambda$.
integral multiple.

Destructive.

Points are out of phase.

Phase diff $= 180°$
path diff $= (2n+1)\lambda/2$
↳ fractional multiple.

Conditions for interference:-

(i) Monochromatic (Having single wavelength)
(ii) Coherence (having constt phase difference)
(iii) Same direction.
(iv) Same medium.
(v) very close to each other.

There is no perfect monochromatic source. but by using filters it is possible to produce a source that gives light whose λ differ by $\pm 5 \times 10^{-10} m$.

If phase diff → constt inteference pattern → static
otherwise → moving

For two ordinary sources → no pattern.
phase → changes rapidly and irregularly.

No:
Date:

(b) Describe Young's Double Slit Experiment and understand the concept of fringe spacing (dark and bright fringes).

→ YDSE obeys → Interference (2nd), diffraction (1st)

(1801) by Young

→ Proves wave nature of light

→ conditions:-

→ coherent light

→ monochromatic light.

→ This experiments is used to study interference of light.

path diff = $d\sin\theta$.

Phase diff = $\varphi = \frac{2\pi x}{\lambda}$

Relation for bright Fringe:-

$d\sin\theta = m\lambda$.

$(m = 0, 1, 2, 3, \ldots)$

$m = 1$ $d\sin\theta = \lambda$

$m = 2$ $d\sin\theta = 2\lambda$.

$m = 3$ $d\sin\theta = 3\lambda$.

Path difference:-

$= 0\lambda, \lambda, 2\lambda, 3\lambda, \ldots$

↳ Integral multiple of λ.

No: Date:

Phase diffrence:-

$= 0, 2\pi, 4\pi, 6\pi, 8\pi, ...$

even multiple of π.

Relation For Dark Fringe:-

$$d\sin\theta = (m + 1/2)\lambda$$

$$d\sin\theta = \left(\frac{2m+1}{2}\right)\lambda$$

$$d\sin\theta = (2m+1)\lambda/2$$

$$d\sin\theta = (2m+1)\pi$$

$$d\sin\theta = 2\pi m + \pi$$

~~m = 0~~ ~~$d\sin\theta = \lambda/2$~~

$m = 1$ $d\sin\theta = 3\lambda/2$

$m = 2$ $d\sin\theta = 5\lambda/2$.

Path diff:-

$\frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}, \frac{7\lambda}{2}, ...$

↳ odd multiples of $\lambda/2$.

Phase diff:-

$\pi, 3\pi, 5\pi, 7\pi, ...$

↳ odd multiples of. π.

Distance of bright fringe from central maxima:-

$$y = \frac{m\lambda L}{d}$$

Distance of dark fringe from central maxima

$$y = (m + 1/2)\lambda L/d.$$

No: Date:

Fringe Spacing:-

distance b/w consecutive bright and dark fringes.

$$\Delta y = \frac{\lambda L}{d}$$

(In YDSE, distance b/w fringes remains same, symmetrical pattern)

$$\boxed{\Delta Y = \frac{\lambda L}{n d}}$$

↳ refractive index

$\Delta y \propto \lambda$
$\Delta y \propto L$
$\Delta y \propto 1/d$
$\Delta y \propto 1/n$

→ In rare medium → speed & λ max.
→ In thick medium → speed & λ min

$\Delta y \propto \lambda$ → red > blue
$\Delta y \propto L$

$\Delta y \propto 1/n$:-

Air > water.

MCQ ✓ If we use white light in YDSE → central will be white
all other → coloured.

$\boxed{\theta \propto \lambda}$

[WIBGYOR]
↳ farthest from centre

Interference:- (in thin film)

Interference in different types of thin films.
→ When exposed to light, thin film produces colourful pattern due to interference.
→ When exposed to monochromatic light only

No: Date:

bright & dark fringes are obtained.

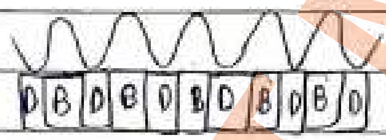
Types:-

Oil Film.
Water Film
Air Film.

Intensity Distribution Diagram:-

→ Geometrical shape of fringes in YDSE are straight line style.
↳ spherical wave front
Plane Wave front.

→ Intensity Distribution Graph is:-



Amplitude remains same.

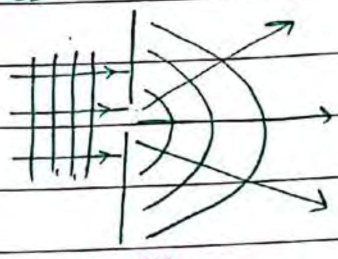
Brightness ↑, Amplitude ↑

No: Date:

(c) Explain Diffraction Grating and solve problems using formula $d\sin\theta = n\lambda$.

Diffraction (Single Slit Experiment):-

Diffraction of light means the bending of light around obstacles or around edges of narrow slits.



Diffraction.

→ Grimaldi of Itlay in 17th century discovered if size of an obstacle is comparable with λ of light, light deviates from rectilinear propagation near the edges and enters geometrical shadow.

→ narrow λ → less bending / straight

→ more λ → more bending.

→ smaller size of diffracting object → greater angle of diffraction.

→ Diffraction due to narrow slit → central maxima and alternative minima on either side.

→ condition for mth order minima on either side of centre $d\sin\theta = m\lambda$.

→ Intensity decreases above/below central Point.

$I \propto A^2$

No: Date:

Diffraction Grating:-

Diffraction grating is a multi slit arrangement of parallel and equally spaced slits. It is made by carving so many closely spaced lines in a glass or plastic sheet.

→ Pattern on screen → due to diffraction + interference

→ Maxima:-

$$d \sin\theta = n\lambda$$

→ ordinary grating:-

400 - 5000 lines per cm.

→ lines → opaque

→ space b/w lines → transparent → behaves as slit

→ Grating Element:-

Distance b/w two slits

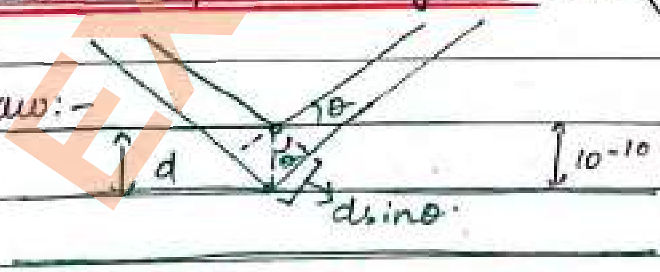
$$d = 1/N$$

N ↳ no. of lines in unit length.

→ white light → colour fringes.

Diffraction of X-rays:- (through crystal)

Bragg's law:-



$$2d \sin\theta = m\lambda$$

d ↓ lattice spacing

interatomic distance.

No: Date:

→ In 1913, Max von Laue suggested that because crystal of NaCl has interatomic distance of $10^{-10}m$ so it could diffract.
↳ comparable to X rays wavelength.

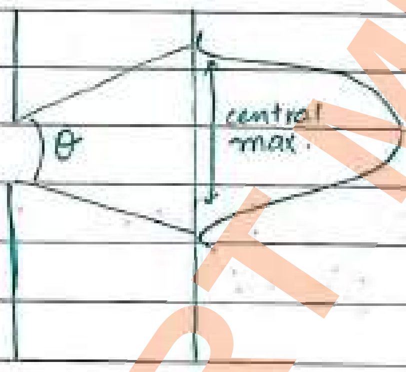
→ To study internal structure of crystal.

→ $\lambda_{light} < \lambda_{sound}$

→ Sound waves are more refracted than light waves

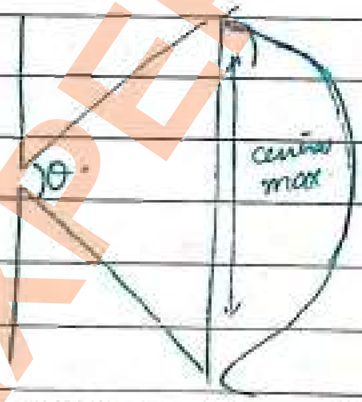
$$\boxed{d\sin\theta = m\lambda}$$

$d \propto 1/\theta$



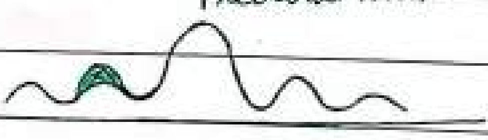
d↑ θ↓ A↑

$d \propto \frac{1}{\theta} \propto A$



d↓ θ↑ A↓

Intensity Distribution diagram for Diffraction.



No: Date:

Mathematical Expression for diffraction maxima and minima are exactly reverse of mathematical expressions for interference maxima and minima

Resolving Power:-

Resolving Power of grating is its ability to separate two wavelength of light in equal order of their spectrum.

$R.P = \frac{\lambda}{\Delta\lambda} = N \times m$

m → order of diff.

N → no. of lines.

$\Delta\lambda$ → Diff in two wavelengths to be resolved.

(d) Explain Basic Principle of optical fibre:-

Introduction:-

→ Graham Bell invented Photo phone to transmit voice message via beam of light.

→ In optical fibre, light is used as transmission carrier wave.

→ The Principle of transmitting signals through optical fibres are.

Total internal reflection $\boxed{\theta > \theta_c}$ → T.I.R

Continuous refraction $\boxed{\theta < \theta_c}$ → refraction

→ denser → rare. } Principle
speed ↓ speed ↑
λ ↓ λ ↑

read as "refractive index of glass w.r.t water) ← $n = \frac{v_w}{v_g}$

No: Date:

Refractive Index:-

It is defined as speed of light in vaccum divided by speed of light in medium.

Index of refraction. ← $n = \frac{c \rightarrow \text{in vaccum}}{v \rightarrow \text{in mdm.}}$

$n = \frac{c}{f\lambda}$ $\boxed{n \propto \frac{1}{\lambda}}$

Snell's law:-

It relates the refractive indices of two media to the direction of propagation in terms of angles to the normal

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1}$

$\sin\theta = \frac{n_2 \rightarrow \text{rare}}{n_1 \rightarrow \text{denser}}$

For air:-
$\sin\theta_c = 1/n_1$
$n_1 = \frac{1}{\sin\theta_c}$

$\frac{\text{Speed of light in core}}{\text{Speed of light in cladding}} < 1$

Types:-

Single mode step index	Multimode step index	Mutimode graded index.
monomode fibre.	Larger core 50μm.	→ diameter = 50-1000μm
narrow core diameter = 5μm	'n' change at boundry of core & cladding	no noticeable → boundry b/w core & cladding
14 TV channels	used for short dist	→ continuous refraction.
14000 phone calls	T.I.R.	→ suitable for long distance.
		→ white light is used.

No: Date: MCQ'S

In YDSE apparatus is taken from air to water, Δy will:

✓a) decrease

b) increase

$\Delta y \propto d/n$

In YDSE, red light is replaced by blue light, Δy will:-

✓a) decrease

b) increase

$\Delta y \propto \lambda$

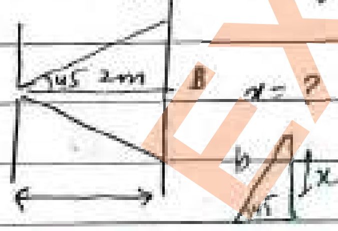
If slit separation become double & screen separation become half, Δy will.

a) become double

✓b) decrease four times

$\Delta y = \frac{m\lambda L}{d}$

In the given diagram



$\tan\theta = \frac{x}{2}$

$1(2) = x$

$x = 2m$

$x = 4m.$

Time taken by light to pass through a glass slab of thickness 2mm is.

a) 10^{-12}

b) 10^{-11}

c) 10^{-10}.

$S = vt$

$t = \frac{S}{v}$; $c/n = \frac{3\times10^{8}}{1.5} = 2\times10^{8}$

$t = \frac{2\times10^{-3}}{2\times10^{8}}$

$\boxed{t = 10^{-11}}$

Light travel through a transparent medium with speed 2×10^{10} cms^{-1}. Find n.

$n = \frac{c}{v}$

$= \frac{3\times10^{8}}{2\times10^{8}} = 1.5$ glass

Light of $\lambda = 3000$ Å in air, it has λ in glass. $(n = 1.5)$

$n = \frac{c}{v}$

$n = \frac{f\lambda_{air}}{f\lambda_g}$

$n = \frac{\lambda_{air}}{\lambda_g} =$

$1.5 = \frac{3000\times10^{-10}}{\lambda_g}$

$\lambda_g = \frac{3000\times10^{-10}}{1.5}$

$= 2000\times10^{-10}$

$= 2000$ Å

No: Date:

In YDSE the 10th maxima of λ is at distance Y_1 and 5th maxima of λ is at Y_2 Find Y_1/Y_2 ?

a) 1:2

✓ b) 2:1

c) 4:1

d) 1:4.

$$\frac{Y_1}{Y_2} = \frac{\frac{m_1 \cancel{\lambda L}}{\cancel{d}}}{\frac{m_2 \cancel{\lambda L}}{\cancel{d}}}$$

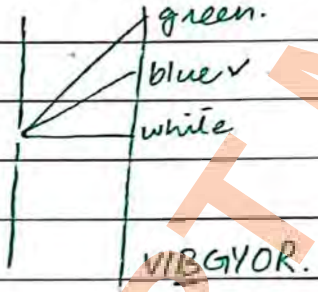
$$\frac{Y_1}{Y_2} = \frac{m_1}{m_2} = \frac{10}{5} = \frac{2}{1}$$

In diffraction phenomena if white light is used then colour of fringe right after central maxima.

a) red

b) green

✓ c) blue



Two waves of amplitude A, intensity I interfere if both have same phase & frequency then.

	A(A)	B(I)
a)	2A	4A
b)	0	0
✓ c)	2A	$4A^2$
d)	2A	$2A^2$

constructive Interf.

$A = A + A = 2A$

$I = (2A)^2 =$

$= 4A^2$

For 2nd order maxima the $\lambda = d$ and screen separation is 6 cm which is distance of 2nd bright fringe from central maxima.

a) 10 cm

b) 6 cm

✓ c) 12 cm

d) 18 cm

$$Y = \frac{m \lambda L}{d}$$

$$Y = \frac{m \cancel{d} L}{\cancel{d}}$$

$Y = mL$

$= 2 \times 6$

$= 12$ cm

If $\lambda = 5 \times 10^{-7}$m illuminate a pair of narrow slit 1mm apart. The Δy of B.F will be if $L = 2$m.

✓ a) 1mm

b) 2mm

c) 0.5mm

d) None.

$$\Delta y = \frac{m \lambda L}{d}$$

$$= \frac{5 \times 10^{-7} \times 2}{1 \times 10^{-3}}$$

$= 10 \times 10^{-7+3}$

$= 10^{-3}$

Date:

In YDSE, $d = 2cm$, $\lambda_1 = 1000\text{Å}$ if distance is half then for what λ_2 the fringes of width 2cm may be obtained on screen.

a) 2000Å ✓

b) 10000Å

c) 500Å

d) 600Å

$\Delta y = \frac{m\lambda L}{d}$

$\Delta y = \frac{(1000)(\text{Å})(L)}{d}$

$\Delta y = \frac{1000\text{ Å}}{2(2\times10^{-2})}$

$= \frac{1000\times10^{-10}}{4}$

In YDSE $\lambda = 6000\text{Å}$ $L = 1m$ $\Delta Y = 0.06cm$ then distance b/w slits is :

a) 1cm

✓ b) 1mm

c) 1×10^{-6}

d) 1×10^{-1}

The formula $d\sin\theta = n\lambda$ is used to locate diffraction minima ; which is correct.

a) 0, 1, 2, 3 . . .

b) 1, 2, 3 . . .

✓ c) ±1, ±2, ±3 . . .

d) 0, ±1, ±2 ±3 .

Refractive Index water $= 4/3$ $n_g = 1.5 = \frac{15}{10} = 3/2$

Find n of water w.r.t glass.

$n = \frac{c}{v}$

$v = \frac{c}{n}$

$n = \frac{v_g}{v_w}$

$= \frac{c/n_g}{c/n_w} = \frac{n_w}{n_g} = \frac{4/3}{3/2} = 8/9$

No: Date:

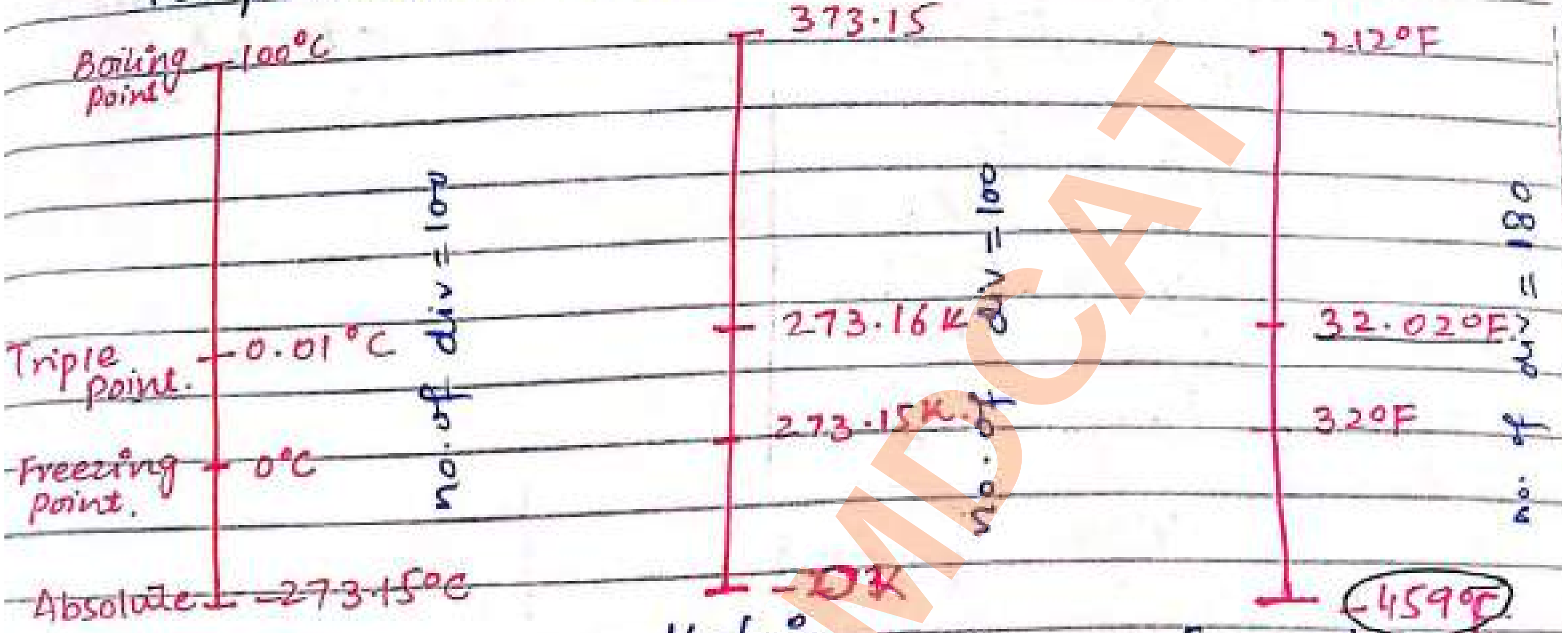
Topic-8
Heat & Thermodynamics

By:-
Maryam

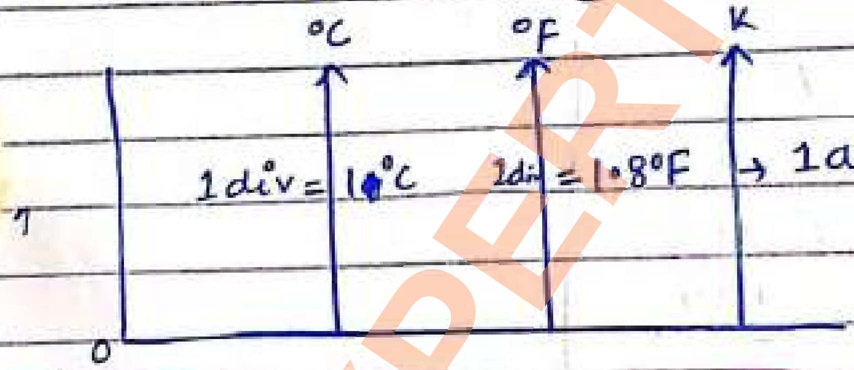
Chapter #11 (Heat and thermodynamics)

↳ 3 mcq's

Temperature Scales:-



Celcius Scale.   Kelvin Scale.   Farrehheit Scale



$\Delta T = \frac{°C}{K}$

If $\Delta T = 20K$ then ΔT in °F will be

a) 20×1.8

$\Delta T = \boxed{1.8\,°C}\,°F$

- To Change in temp in °F from °C/K we always multiply 1.8.

Conversion Scale:-

$$\frac{C-0}{100} = \frac{K-273}{100} = \frac{F-32}{180}$$

A what temp °C = °F
−40°C (no unit)

$$\frac{C-0}{100} = \frac{F-32}{180}$$

$$\frac{C}{100} = \frac{F-32}{180}$$

$$\frac{°C}{10} = \frac{F-32}{18}$$

$$\frac{°C}{5} = \frac{F-32}{9}$$

$$°C = \frac{5}{9}(F-32)$$

MCQ T=50°C what is T in F

$$\frac{C-0}{100} = \frac{F-32}{180}$$

$$\frac{50}{100} = \frac{F-32}{180}$$

2

$$2(F-32) = 180$$

$$2F-64 = 180$$

$$2F = 180+64$$

$$2F = 244$$

$$F = 122°F$$

Kinetic Theory of Gases:-

Change in momentum = $-2mv$

Mean sequare velocity:-

$$\langle v^2 \rangle = \frac{v_1^2+v_2^2+ - - - +v_N^2}{N}$$

Root-Mean square velocity:-

$$\langle v_{rms} \rangle = \sqrt{\frac{v_1^2+v_2^2+ - - - +v_N^2}{N}}$$

Pressure of gas.

$$P = \frac{1}{3}\rho\langle v^2 \rangle$$

$$\therefore \quad \rho = \frac{m}{V}$$

$$\boxed{\rho = \frac{Nm}{V}}$$

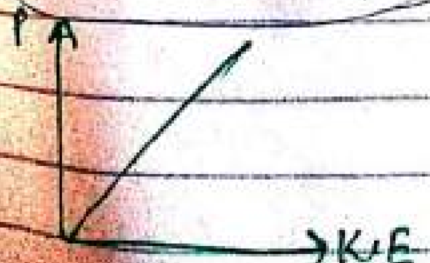
$$P = \frac{1}{3}\frac{Nm}{V}\langle v^2 \rangle$$

$$P = \frac{2}{3}\frac{N}{V}\left\langle \frac{1}{2}mv^2 \right\rangle$$

$$P = \frac{2}{3}\frac{N}{V}\langle K.E \rangle_T$$ Average translation Kinetic energy

$$P = \frac{2}{3}N_0\langle K.E \rangle_T.$$

$$P \propto \langle K.E \rangle_T$$



Interpretation of Temperature.

Root mean square velocity
$C \propto \frac{1}{\sqrt{m}}$

$\Delta\theta = \Delta T$ ↳ change in temp

$PV = nRT$

$PV = \frac{N}{N_A} RT$

$PV = NKT$ ↳ $1.38 \times 10^{-23}\ JK^{-1}$ ↳ same as entropy

As

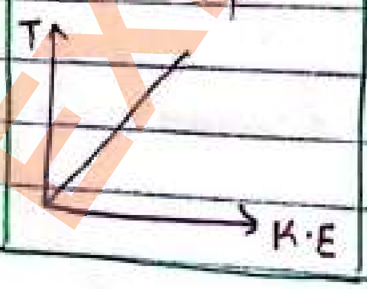
$P = \frac{2}{3}\frac{N}{V}\langle K.E\rangle_T$

$PV = \frac{2}{3}N\langle K.E\rangle_T$

$\cancel{N}KT = \frac{2}{3}\cancel{N}\langle K.E\rangle_T$

$\boxed{T = \frac{2}{3K}\langle K.E\rangle_T}$

$T \propto \langle K.E\rangle_T$



Conclusion:-

$T = \frac{2}{3K}\langle K.E\rangle$

$T = \frac{2}{3K}\langle \frac{1}{2}mv^2\rangle$

$\frac{3KT}{m} = v^2$

$\sqrt{v^2} = \sqrt{\frac{3KT}{m}}$

$v = \sqrt{\frac{3KT}{m}}$

$v \propto \sqrt{T}$

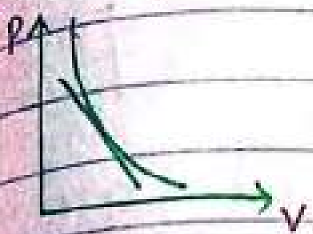
$v \propto \frac{1}{\sqrt{m}}$

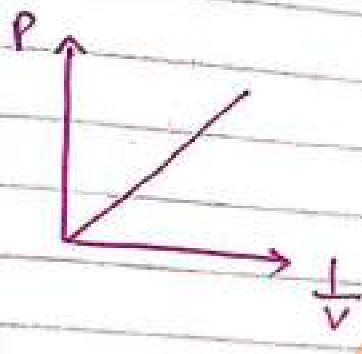
...le's Law:-

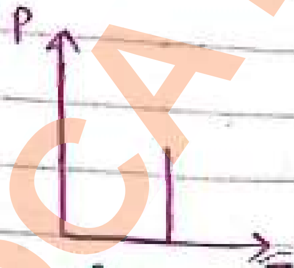
$PV = constt.$

unit ↳ Joule.

$P \propto \frac{1}{V}$

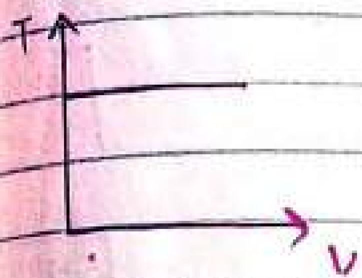






Because Temperature is constt.

Slope = −ve.

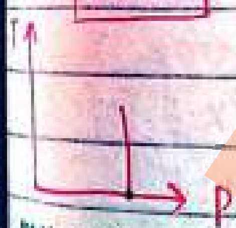


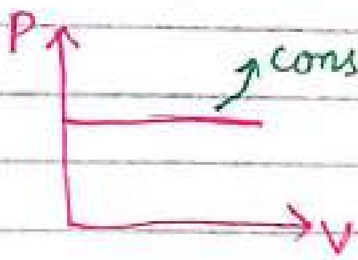
Charles Law:-

P → constt.

$\frac{V}{T} \rightarrow constt \rightarrow \frac{m^3}{K}.$ ✓

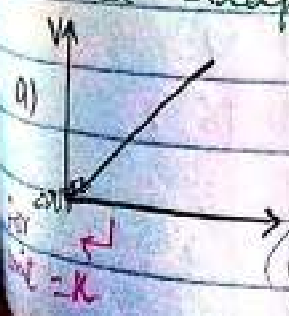
$\boxed{V \propto T}$



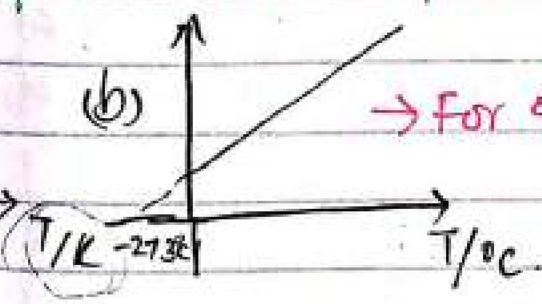


Which Graph is correct for absolute temp.

(a)



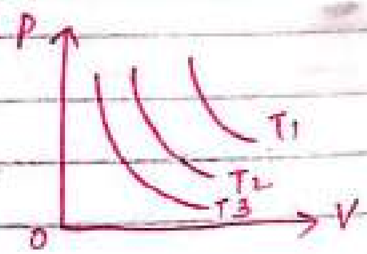
(b)



→ For °C

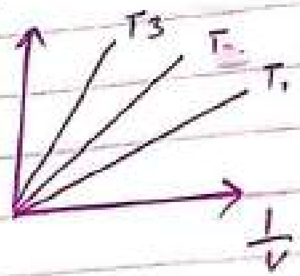
P–V Graph.

MCQ



a) $T_1 = T_2 = T_3$
b) $T_1 > T_2 > T_3$
c) $T_1 < T_2 < T_3$

MCQ.



$T_3 > T_2 > T_1$

MCQ
Three particles having speed $2ms^{-1}$, $1ms^{-1}$ & $3ms^{-1}$. Find root mean square velocity.

$$V_{rms} = \sqrt{\frac{V_1^2 + V_2^2 + V_3^2}{N}}$$

$$= \sqrt{\frac{(3)^2 + (2)^2 + (1)^2}{3}}$$

$$= \sqrt{\frac{9+4+1}{3}}$$

$$= \sqrt{\frac{14}{3}}$$

From the given data

V (ms^{-1})	1	2	3	4	5
Part	1	1	4	1	1

$V_{rms} = ?$

$$= \sqrt{\frac{V_1^2 + V_2^2 + V_3^2 + V_4^2 + \ldots}{1+1+4+1+1}}$$

$$= \sqrt{\frac{(1)^2 + (2)^2 + (3)^2 + (4)^2 + (5)^2}{8}}$$

$$= \sqrt{\frac{1+4+(12)^2+16+25}{8}}$$

$$= \sqrt{\frac{5+144+41}{8}}$$

$$= \sqrt{\frac{144+46}{8}} = \sqrt{\frac{190}{8}}$$

A vessel contain 2 mol O_2 and one mole N_2 at 200K. The ratio of K.E of N_2 to O_2

a) 1 : 4
b) 8 : 1
c) 1 : 1
d) 16 : 1

Temp = same

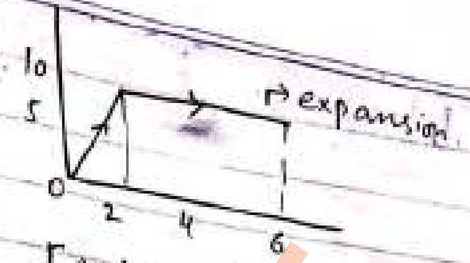
Two particles having mass m_1 and m_2 then $c_1 : c_2 = ?$

a) $\frac{m_1}{m_2}$

b) m_2/m_1

c) $\sqrt{m_1/m_2}$

d) $\sqrt{\frac{m_2}{m_1}}$



Find w during expansion from 2–6 m3.

$4 \times 10 = 40\,J$

Internal Energy

Sum of all K.E + P.E

↓

→ translational, vibrational, rotational

If temp (isothermal) is constt, then

i) internal energy will be constt.

ii) change in Internal energy = zero

→ State Function

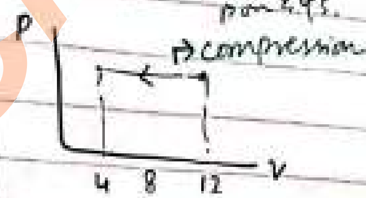
→ denoted by 'U'

→ independent of path

→ only depend upon temperature

→ analogous of G.P.E

→ Unit → J



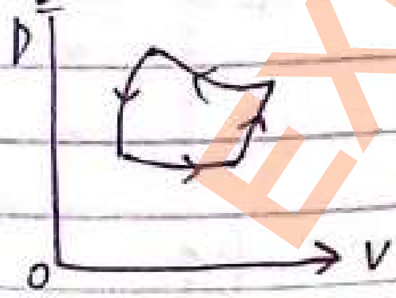
Find work.

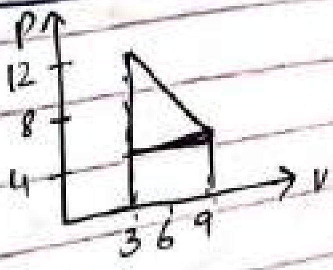
$= 8 \times 4$

$= 32\,J$

$= -32\,J$ ✓

MCQ



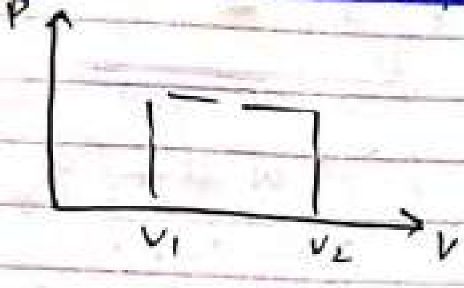


$= 6 \times 4 + \frac{1}{2} \times 6 \times 8$

$= 24 + 24$

$= 48\,J$

Work & Energy:-

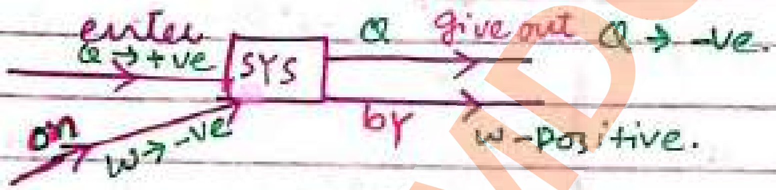


Area under PV graph gives work.

$W = P(V_2 - V_1)$

$W = P\Delta V$

PnT → with respect to surrounds



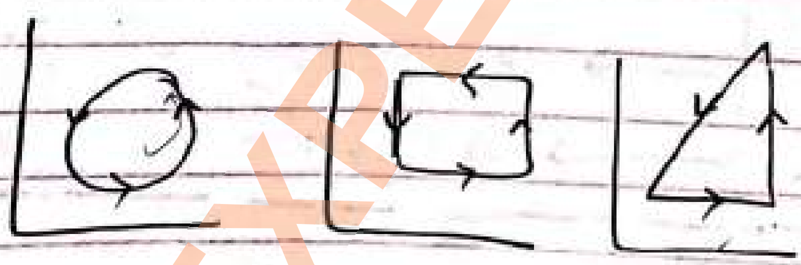
Expansion:-

W → by the sys → +ve.

Compression:-

W → on the sys → -ve

★

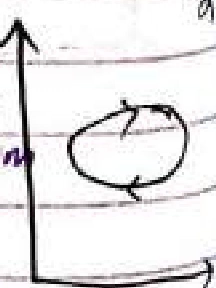


Clockwise → +ve

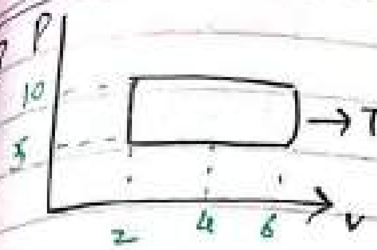
anticlockwise → -ve.

In cyclic process, for thermodyn[amic] work done will be ma[x]

work = zero



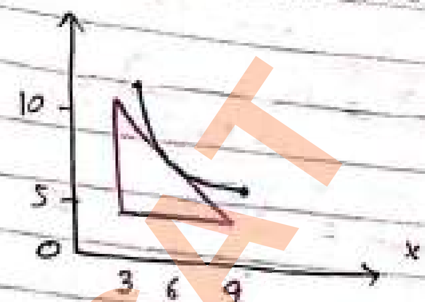
work maximum



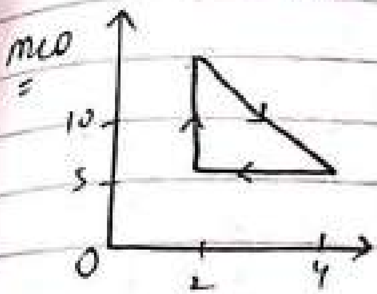
$= 4 \times 5$

$= 20J$

If closed



mcq =



$= \cancel{6 \times 4 + \frac{1}{2} \times 6 \times 8}$

$= \frac{1}{\cancel{2}} \times \cancel{2} \times 5$

$= 5J$

$= \frac{3}{\cancel{6}} \times 5 + \frac{1}{2} \times 6 \times 5$

$= 15 + 30$

$= 45J$

↳ less than

mcq =

Reading = pg# ✓ 236-250

pg# ✓ 252-253

pg# ✓ 256

$W = \pi r^2$

$W = \pi \times 5^2$

$W = 25\pi J$

1^{st} Law of Thermodynamics

$\Delta Q = \Delta U + \Delta W$

ΔQ → heat, ΔU → Int. E, ΔW → work.

→ obey law of conservation of Energy

	+ve	−ve
ΔQ	heat supplied	heat given out
ΔW	By the syst.	on the sys.
ΔU	T is inc.	T is dec.

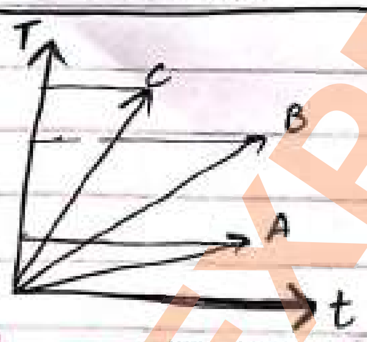
Specific Heat:-

$Q = mc\Delta T$

$c = \dfrac{Q}{m\Delta T}$

$c \propto \dfrac{Q}{\Delta T}$

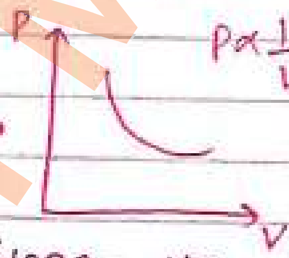
MCQ



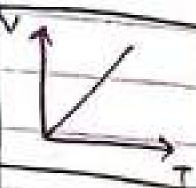
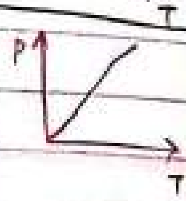
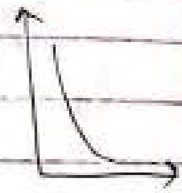
$T\downarrow \; C\uparrow$

c is maximum for which slope.

(A)→ Temp ↓ $C\uparrow$:

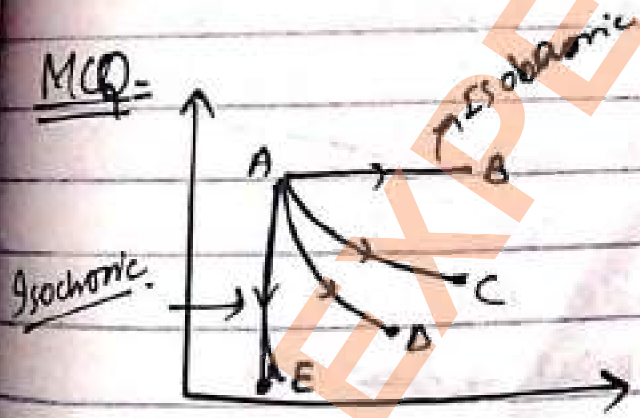
Isothermal	Adiabatic
• Temp → constt $\Delta T = 0$	No heat enter or leave the $\boxed{\text{system}}$
• obey Boyle's law	
• PV = constt	PV^{γ} = constt
 $P \propto \frac{1}{V}$	
Slope = −ve	slope = −ve → steepness • rapid change
	• Rapid Process
e.g. melting and boiling Point.	Cloud formation
$Q = mc\Delta T$ $c = \dfrac{Q}{m\Delta T}$ $\Delta T = 0$ $c = \infty$	$Q = 0$ $c = 0$

$W_{baric} > W_{isoth} > W_{adia}$ ← Isothermal
↳ heat loss MMM
So work
not maximum

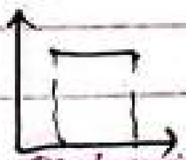
Process	Constt	Relation	$\boxed{\Delta Q = \Delta W + \Delta U}$	Graph.
Isothermal	T, $\Delta T = 0$	$PV = $ constt $P \propto \frac{1}{V}$	Temperature constt → $\Delta U = 0$ $\boxed{\Delta Q = \Delta W}$	
Isobaric maximum work	P	$\frac{V}{T} = $ constt $V \propto T$	$\boxed{\Delta Q = \Delta U + P\Delta V}$	
Isochoric IKMT. $\boxed{W = 0}$	V	$\frac{P}{T} = $ constt $P \propto T$	$\Delta V = 0$ so $\Delta W = 0$ $\boxed{\Delta Q = \Delta U}$	
Adiabatic	$Q = 0$	$PV^{\gamma} = $ constt	$Q = 0$ $\Delta Q = \Delta W + \Delta U$ $0 = \Delta W + \Delta U$ $\Delta U = -\Delta W$ $\Delta W = -\Delta U$	

Expansion/compression → mcq's men iska khyaal rakhna hai.

MCQ-



MCQ



Isobaric

Isothermal

Adiabatic.

A → E Isochoric.

A → C Isothermal ✓

A → B Isobaric

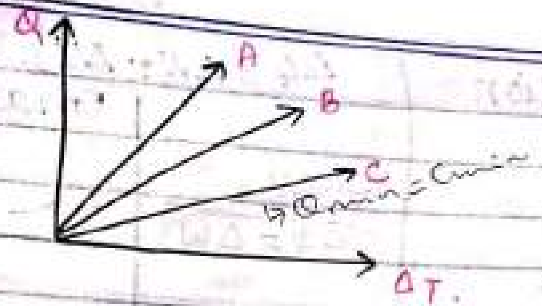
A → D Adiabatic.

$W_{baric} > W_{isoth} > W_{adia}$.

$Q = mc\Delta T$

$C = \frac{Q}{...}$

MCQ's.



$C_{min} = ?$

Slope c

$C \propto \frac{\Delta Q}{\Delta T}$

mono → one dimension
↳ translational
Poly / Di
↳ both transl and rotational

$\gamma = \frac{C_p}{C_v}$

$C_p - C_v = R \rightarrow 8.314\ J/mol/K$

✓ Ch # 8 (Pg # 168 Side Table)

Gases	Cv	Cp	$\gamma = \frac{C_p}{C_v}$
mono	$\frac{3}{2}R$	$\frac{5}{2}R$	$\frac{5}{3} = 1.67$
Diat	$\frac{5}{2}R$	$\frac{7}{2}R$	$\frac{7}{5} = 1.40$
Polyat	3R	4R	$\frac{4}{3} = 1.29$

mcq.

$C_p - C_v = R$

If

$C_v = \frac{5}{2}R.$

$C_p - C_v = R.$

$C_p - \frac{5}{2}R = R$

$C_p = \frac{5}{2}R + R$

$C_p = \frac{5R + 2R}{2}$

$C_p = \frac{7}{2}R.$

Ex 11.3

Pg # 252. (Heat engine) ✓
↳ application of 2nd law of thermodynamics.

1st law → Formula.

2nd law → utilization of 1st law.

All energy can not be converted to work.

Pg # 254 (side-info).

Triple point → reading

T.P.W = 273.16 K

Diff b/w freezing & Triple point of water = 0.01 → celsius → 0.01

Farenheit = 0.01 × 1.8

= °F

$\boxed{°F = 18 \times 10^{-3}}$

$\frac{0.01 \times 1.8}{100}$ $\frac{18}{10}$

$\frac{18}{1000} = 1.8 \times 10^{-3}$

• Under $\Delta V =$ Then

• Due = 70

MCQ's

MCQ's Du

MCQs

work done by sys (+ve)
$\Delta U \downarrow\downarrow$
$\rightarrow T \downarrow\downarrow$

MCQ's • Under adiabatic expansion
$\Delta U = 20J$
Then ΔW will be.

$\Delta W = -\Delta U$
$\Delta W = -(-20J)$
$\Delta W = +20J$

• work done on sys(−ve)
$\rightarrow T\uparrow\uparrow \quad \Delta U\uparrow\uparrow$

MCQ's • During compression, $\Delta U = 70J$, ΔW will be.

$\Delta W = -\Delta W$
$= -70J$

MCQ's During expansion, $\Delta W = 150J$
ΔU will be.

$\Delta U = -W$
$= -150J$

$T\downarrow \; U\downarrow$
−ve

MCQ's During compression $\Delta W = 90J$, ΔU will be.

$\Delta U = -W$
$= -(-90J)$
$= +90J$

MCQ's If the molecule in tank of Hydrogen have same V_{rms}, as the molecules in the tank of oxygen, then we may sure that

a) Pressure same
b) Oxygen is at $T\uparrow$
c) H_2 is at $P\uparrow$
d) H_2 is at $T\uparrow$

The resulting Pressure P_2 is given by.

$\boxed{a)}$ $P_2 = \left(\frac{V_1}{V_2}\right)^{\gamma} P_1$

b) $P_2 = \left(\frac{V_2}{V_1}\right)^{\gamma} P_1$

c) $P_2 = (V_2 V_1)^{\gamma} P_1$

d) $P_2 = \left(\frac{V_1}{V_2}\right)^{\frac{\gamma}{\gamma-1}} P_1$

$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

$P_2 = \left(\frac{V_1}{V_2}\right)^{\gamma} P_1$

- A 50g block of solid ($c = 0.9 kJ/kg°C$) is at 20°C, absorb 100J of heat, which one of the following is best approximate increase in T:-

$C = ?$

$mc\Delta T$

a) 1°C

b) 2°C

c) 4 K

d) 0.5K

$m = 50g$

$q = mc\Delta T$

$\Delta T = \frac{Q}{mc} = \frac{(100J)}{(50)(\cancel{0.9})}$

$= \cancel{\frac{20\ 1000}{9\ 450}} = \frac{\times 10^{-3}}{\cancel{1000 \times}}$

$= \cancel{\frac{20}{9} \times 10^{-3}} \cancel{8}. = \frac{100}{(50 \times 10^{-3})}$

$=$

When 2 ... from 0° ... volume, ... change

$c = ?$

a) 5 J

b) 2...

c) 4...

d) ...

A

a

b)

c)

d

T

is

fi

1...

i

X

Scanned by CamScanner

When 2 mole of gas heated from 0°C to 10°C, at const volume, its internal energy changes to 420J, what is c = ?

a) 5 J/molK.
b) 20 $Jmol^{-1}K^{-1}$
c) 42 $Jmol^{-1}K^{-1}$
d) ~~5.10J~~ 10.5 $Jmol^{-1}K^{-1}$

$Q = mc\Delta T$

$c = \frac{Q}{m\Delta T}$

$= \frac{420}{(2)(10)}$

$= 21\ Jmol^{-1}K^{-1}$

$\boxed{\Delta Q = \Delta U}$ → For const V

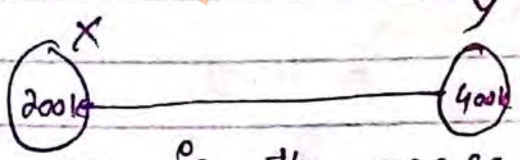
$\boxed{W = 0}$

A box contain 'n' molecule of gas, how will the pressure of gas be effected if number of molecules become 2n

a) P will dec by 4 times
b) P becomes double
c) P decreases by two times.
d) P remain same.

$P = \frac{2}{3}\frac{N}{V}\langle K.E\rangle$

The volume of sphere 'X' is twice of Y both are filled with ideal gas as shown.



if 'm' is the mass of gas in X then the m' in Y will be

a) 2m
b) m/2
c) m/4
d) 4m.

$PV = nRT$

$PV = \frac{m}{M}RT$

The temp of gas molecule is 100K. For what temperature its speed would becomes double
a) 800 K
b) 400 K
c) 200 K
d) None of these

$\boxed{V_{rms} \propto \sqrt{T}}$

$V_{rms} \propto \sqrt{100}$

$2V_{rms} \propto \sqrt{400}$

$\sqrt{900}$ $2\sqrt{100}$

For what temp V_{rms} would becomes three times (900)

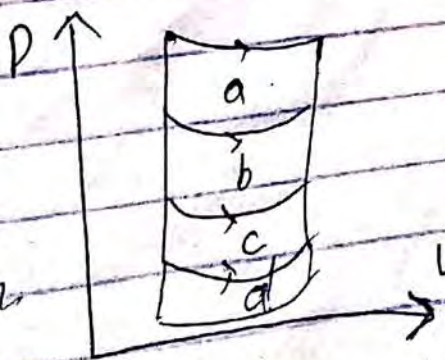
The temperature for V_{rms} would becomes n times $\Rightarrow$ $\boxed{T' = n^2 T}$

An ideal gas is heated at 700 K, at pressure 3.5 atm under the isobaric process then volume is halve The new temperature will be?

350

$\boxed{V \propto T}$
Charle's law

For what region the work is maximum.



a) ab
b) bd
c) cd
d) ad.

A↑ W↑ (ad)

Ex 11.5
Pg 251
Last Paragraph
S.Q's
11.1
2, 3, 4, 5, 10, 9
11.2, 1, 3, 4, 11,

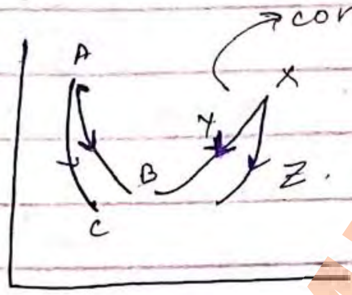
Conduction
heat transfer without motion of particle.

due to movement of particle
convection

heat transfer due to rays
fastest
with speed of light.

Pg #274.
random error

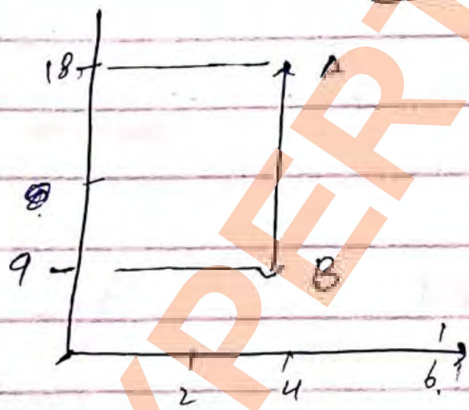
In adiabetic expansion
$\Delta W = 600J$
$\Delta U = ?$
1st law of theemodynamic would become.
$-600J$.



which curve representing isotheemal expansion

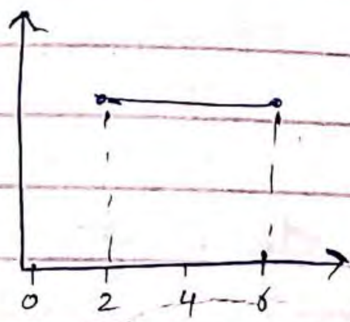
AB

AC Adiabatic.



(a)

Isobaric



(b)

Isochoric
$W = 0$